AMERICAN SOCIETY
JUL 12 1906
OF CIVIL ENGINEERS
NEW YORK.

(9)

Transactions of the American Foundrymen's Association

Comprising the

Report of the Convention at Cleveland, Ohio June 5th, 6th and 7th, 1906

With the

Reports of the Committees and Officers, and the Papers presented at this Meeting

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Preface

It will be remembered that in order to economize on the printing expenses an arrangement was made two years ago between the American Foundrymen's Association and *The Foundry*, by which *The Foundry* set up all of the matter for the papers and had the transactions printed, with the idea of using a large portion of the matter subsequently in *The Foundry*. Two years ago about 80 per cent of the papers were ultimately reprinted in *The Foundry*, and last year about 65 per cent were printed in full and a number of the others in abstract. This year they will be used in the same manner.

This arrangement is a great saving to the A. F. A. financially and has enabled the old debts to be paid off. Papers which do not appear in time for publication previous to the meeting will be published later and paged consecutively with those printed previous to the convention so that the latter may be bound in the form of a printed volume. After the discussion has all been received and printed a subject and author's index will be gotten up and printed, which will complete the volume of Transactions for the current year.

The papers of the A. F. F. are included with those of the A. F. A.

15676

THE BENEFICIAL EFFECTS OF ADDING HIGH GRADE FERRO-SILICON TO CAST IRON.*

ALEXANDER E. OUTERBRIDGE JR.

The conjurer's familiar trick of pouring a number of different liquids, such as milk and water (not combined), red ink, black ink, claret and sometimes even stronger liquids, from one bottle in any order named by his andience, is a never failing wonder and surprise to juveniles and even to children of larger growth.

A less sensational, but far more practical problem has long engaged the attention of metallurgists, viz.: how to economically obtain from one cupola, in one heat, a variety of grades of molten iron suitable for different kinds of castings ranging, let us suppose, from those requiring high chilling iron such as chilled cast iron car wheels, or, from castings of high tensile and transverse strength, to small castings requiring extreme softness and ductility, in which great strength is not looked for. The wide variations in physical properties of cast iron are due to two combined causes, chemical composition and rate of cooling from the liquid state. Strength and softness are antagonistic qualities rarely found united.

Good car wheel iron is a strong metal containing less than one per cent of silicon, having nearly one-half of its carbon chemically combined. Stove plate iron is a weak metal containing about three per cent of silicon and very little, if any, combined carbon. Car wheel iron would be entirely unsuitable for stove plates, while stove plate iron would be useless for car wheels. Again, the metal which would be adapted to cast iron turn tables for large locomotives, or the iron intended for bed plates of heavy machinery and the like would not be suitable for either of the foregoing purposes.

* To be presented also before the American Society for Testing Materials.

It is the universal custom therefore, to pour car wheels from special mixtures having suitable chilling property, and stove plates are poured from entirely different mixtures in different cupolas, and it has but little chilling property, but the modern metallurgist or general practitioner is daily called upon to provide metal melted in one cupola and one heat, suitable for a great variety of castings and requiring, if the best results are desired, wide variations in physical properties as well as chemical constituents. The method adopted by the author many years ago and which is, no doubt, practiced by others to meet these varying requirements in a thoroughly practical manner, has been to group all the small work for the day, needing soft ductile iron, so that it will be cast at the beginning, or near the beginning, of the run of iron from the cupola, which is, of course, charged with the required amount of the softest grades of iron; the proportion of silicon in such mixtures approximating 2½ per cent. This is followed by a medium grade of iron, calculated to contain about 1.9 per cent silicon, giving a product suitable for miscellaneous castings of medium weight and thickness, and capable of being machined readily, but not too soft to give good wearing service; this, again, is followed by strong iron mixtures intended for large and heavy work requiring close graned texture and usually high tensile and transverse strength. The strong iron may have as little as one half of one per cent of silicon and may possess high chilling property. The transverse strength of the soft iron (2½ per cent silicon) when cast in bars one inch square section and fifteen inches long, broken in the middle with supports 12 inches apart one ranges from about 1,900 pounds to about 2,200 pounds and the tensile strength per square inch of the same bars, when turned and pulled on a machine, having automatically adjusted grips to insure a perfectly straight

pull while the piece is being strained, averages ten times the transverse stress, or, 19,000 to 22,000 pounds per square inch.

The medium iron (1.9 per cent silicon) averages 2,500 pounds transverse strength and 25,000 pounds tensile strength per square inch cast in the same size bars and tested under the same conditions. The strong iron should exceed 3,000 pounds transverse strength and 30,000 pounds tensile strength of the same bars in the regular daily work.

"Special castings" have been made in the foundry of William Sellers & Co., Incorporated, (where the author has been engaged for nearly 20 years as metallurgist) which have united the two antagonistic properties of high tensile strength with softness and ductility in a remarkable degree. Tensile test of bars ½ inch square section (being the same thickness as the castings) formed in the same mold with the castings and attached thereto, have shown, when turned and pulled on the 100,000-pound emery hydraulic testing machine extraordinary tensile strength, viz: 40,535 pounds to 44,565 pounds per square inch. These are believed to be the highest records ever noted for soft cast iron, if indeed they are not the highest for any kind of cast iron melted in a cupola.

It is of course impracticable to obtain a perfectly sharp dividing line between the soft iron, medium iron, and strong iron charged in a cupola and in the molten metal withdrawn therefrom, for it is impossible to prevent a portion of the product, if the composition is varied during the charging of the cupola from being to a certain degree variable, so as not to be accurately predictable as to its composition and physical properties in individual taps at the time when the metal is tapering off from one grade to another.

To overcome this uncertainty it is customary, in the foundry already named, to arrange the daily work so as to have a certain number of castings serve as "buffers," i. e., to take iron that is intermediate between the different grades charged in the furnace, and this method has proved very satisfactory. The buffers are usually castings that require but little machining and in which a considerable variation of composition of the metal is permissible. There are always plenty of such castings made in every foundry each day.

To supplement this routine method by a simple and cheap process of varying the chemical constituents and physical properties of molten iron after it has been tapped from the cupola and removed from the source of heat, is a desideratum devoutly to be wished for, and many efforts have been made to perform the trick. The prime difficulty is found in the fact that the melting point of cast iron is lower than that of nearly all of the metals or metalloids that are suitable for the purpose. For example, the addition of wrought iron or steel to cast iron increases its strength and chilling properties. It is a common practice to add steel in the cupola for this purpose, but, if the attempt be made to incorporate steel or wrought iron in the form of chips or small pieces in a ladle of molten iron withdrawn from the source of heat supply, it will be found unsatisfactory, for the reason that the melting point of steel is too high to permit of a sufficient amount of it to be dissolved in and diffused throughout the molten iron to effect a radical change in physical property without causing dull iron to result therefrom.

The element silicon is practically the governor that determines the degree of hardness of cast iron, therefore the value of a single and inexpensive process that would enable the intelligent founder to control the proportion of silicon in any individual ladle of molten iron drawn from the melting furnace would be at once apparent, especially in foundries where miscellaneous castings, ranging in size from small pulleys, with rims one-quarter inch thick, bed plates for various machines, hydraulic cylinders and the like, sometimes weighing many tons and of various thickness, up to a foot or more as is the daily practice in many foundries.

In the year 1886 the author made

many experiments in this direction, using the richest grades of ferro-silicon then obtainable, containing from 10 per cent up to 18 per cent of silicon, by adding the alloy in small lumps or in powder to ladles of molten iron, but found that the metal would not dissolve a sufficient quantity of the alloy to greatly change the proportion of silicon and thus to produce a marked increase in softness of the iron without appreciably affecting the temperature and fluidity of the molten iron. Preheating the alloy was the next logical step tried with an improved result, but it was soon ascertained that the inconvenience and cost of heating the alloy red hot would militate against its general usefulness. At the same time it was found that the addition of a small amount of ferro-manganese containing 80 per cent manganese (then a commercial product) accomplished the object sought in car wheel mixtures in a totally different manner by changing the condition of the carbon and without the necessity of heating the alloy. Therefore the tests with ferro-silicon were discontinued. In recent years electro-metallurgy has made giant strides and it is now possible to obtain commercially pure silicon (over 98 per cent pure) and ferro-silicon alloys of extreme richness ranging from 50 per cent to 80 per cent silicon or over. This fact caused the author to again take up the experiments of adding silicon to ladles of molten cast iron where he had left off in 1886. A quantity of 98 per cent silicon, made in an electric furnace at Niagara Falls, was obtained in large lumps, this material resembles in appearance 80 per cent ferro-manganese but is very much lighter in weight, bulk for bulk, the specific gravity being about one-third that of 80 per cent ferro-manganese and less than one-third that of cast iron. Many tests were made with this new material which resulted in failure, owing partly, no doubt, to the very high melting points of silicon (about the same as steel) and partly to its levity which caused the powder to float to the surface of the molten iron if sprinkled into the ladle, or to simply cake if tested to the bottom. When an alloy of silicon and iron containing 50 per cent of silicon was used, however, a very different result was noted. This material was obtained in the form of coarse powder and was sprinkled into the molten iron as it was tapped into the ladle. Instantly the surface of the molten iron became "alive," as the workmen aptly expressed it; a rapid circulation of the skin of oxide which always forms on the surface was noticed, moving in circles like ripples from the center toward the edge of the ladle, this lively movement continued until the metal was poured and the same movement was noticed in the gates and risers of the castings. The usual test bars were poured both from the treated metal and from the same iron untreated. "Chill test pieces" were also poured into heavy iron cups, which serve by the extremely rapid cooling of the small chill test bars to magnify any chilling property just as a microscope magnifies any minute object. Few practical founders are aware of the fact that there is a very great difference in the chilling property of soft foundry irons, as the metal if poured in a sand mold, even in very thin section, does not show an appreciable chill, yet it does show the effect of such concealed chill under the machining operations of drilling, planing or milling, for the reason that particles of iron containing combined carbon may under such conditions be distributed throughout the castings, which are too minute to be seen by the naked eye, but destroy the cutting tools. The chill cup test is in effect a physical analysis of practical value which enables the foundry foreman to know the character of every ladle of iron, small or large, before he pours his metal. The little tapered bars poured in the cups become solidified immediately, are then turned out, cooled in a bucket of water and broken. Such tests are poured from every tap, broken at once and placed in a row for the foreman's inspection.

The chill cup tests of the treated and untreated iron in the foregoing experiment showed at once that the small amount of 50 per cent ferro-silicon added, viz: half a pound in a 200-pound

ladle, had dissolved in the iron wiping out the chill in the metal almost completely. The regular transverse test bars when broken showed two very interesting features, one of which was anticipated, the other unexpected. The metal of the treated bars was much softer in appearance as was already indicated by the chill cup tests, but, instead of being weaker, the treated bars were *all stronger than the untreated bars.* In other words, increased softness and increased strength (too usually antagonistic properties) were here combined. The castings poured from the treated metal were small pulleys having rims about ¼-inch thick that are ordinarily turned at a speed of 25 feet a minute. The treated pulleys were turned without destroying the cutting edge of the tool at 40 per minute as shown by memoranda furnished by the lathe operator.

The success of these initial tests led at once to more extended investigations all corrobating the correctness of the first observations. Analysis showed that the actual increase in silicon was slightly less than the calculated increase, and further tests showed that there is a limit to the amount of the alloy that can be incorporated, depending upon the initial heat of the iron and the size of the ladle.

Another interesting observation is that a given increase of silicon, say one quarter of one per cent, imparted to molten iron in this manner is more effective as a softener than an equal increase of silicon imparted through the cupola in the charging of the iron, which any increase of silicon in the cupola always causes a corresponding decrease in strength of the metal. The rationale of the increase in strength with increased softness discovered in these tests is, in all probability, to be found in the deoxidation of the iron by the silicon added in its nascent condition. It is now quite generally believed that there is a small amount of oxide of iron dissolved in all iron melted in a cupola (notwithstanding the high percentage of free carbon) and that this oxide is a weakening element. Silicon has a strong affinity for oxygen and presumably seizes upon the oxygen of the dissolved iron oxide, liberating the iron, the silicon (oxide of silicon) thus formed having specific gravity of only 2.41 as compared with 7.15 the sh. gr. of cast iron, rises to the top, thus accounting for the two facts herein noted, viz:, the rapid circulation of the skin on the surface of the molten iron in the ladle, and the apparent slight loss of silicon when added in the alloy. The reason why an alloy of iron and silicon, rich in the latter element, dissolves and diffuses throughout the molten mass, while pure silicon will not, is probably owing partly to its relatively high specific gravity (over 6) and partly to the fact of already being alloyed with iron which melts and acts as a diffusing vehicle enabling the silicon to become incorporated with the molten iron. The action is very similar in this respect to that of manganese in the 80 per cent ferro-manganese already spoken of.

Not desiring to extend this paper to undue length, details of many similar tests are omitted which, it may be said, have resulted in the practical adoption of this method of treating iron in the ladle in the foundry of Wm. Sellers & Co. Incorporated, as a ready and reliable means of producing very soft and at the same time strong iron for small castings from metal of medium grade which would not otherwise be so well adapted for the purpose.

The 50 per cent powdered ferro-silicon used costs about four cents per pound at the present time, but, as the quantity required to produce the desired result is so small, viz:, about half a pound, or less, to a hundred pounds of iron, the cost is really trifling, and is far more than counterbalanced by the fact that cheaper grades of pig iron may be used in the furnace. Added to this is the great practical value of being thus able to control the product absolutely and to vary the character of the metal in regard to softness, or machining quality, while at the same time increasing the strength and ductility of individual ladels of molten iron drawn from one common source.

The author's experiments in adding 80

XUM

per cent ferro-manganese to car-wheel iron in ladles in the year 1886 briefly alluded to have been thoroughly exploited years ago in technical journals and have been frequently mentioned by other writers. The process has come into large daily use and its merits and limitations are familiar to all car-wheel makers and most metallurgists it is not considered necessary therefore to refer at length to the subject in this place.

Appended hereto is a small table of a few tests of treated and untreated bars of soft and medium grades of iron all showing gains in strength ranging from 2 3-10 per cent to 26½ per cent, and in deflection of the bars from 7 14-100 to 31 per cent, while the increase in softness was very marked indeed. It is hoped that these few records may prove interesting and valuable to founders.

RESULTS OF TESTS OF FERRO-SI IN LADLES.

Date	Remarks % Si	Breaking Strain (Pounds)	Deflection (Inches)	Resilience	Shrinkage (Inches)	% Gain		
						Break'g strain	Deflection	Resilience
Oct. 10, '05	¼ lb Hand	2265	.120	45.30	.192			
	Ladle	2155	.112	40.09	.191			
	Gain	110	.008	5.21		5.1 %	7.14 %	13. %
Oct. 11, '05	¼ lb Hand	2215	.137	50.51	.182			
	Ladle	2165	.124	44.60	.185			
	Gain	50	.013	5.91		2.3 %	10.4 %	13.2 %
Oct. 14, '05	¼ lb Hand	2600	.152	65.79	.196			
	Ladle	2055	.116	39.18	.188			
	Gain	545	.036	26.61		26.5 %	31. %	67. %
Oct. 15, '05	¼ lb Hand	2380	.143	55.45	.183			
	Ladle	1893	.110	34 60	.183			
	Gain	487	.033	20.85		23.8 %	30. %	60.2 %
Oct. 16, '05	¼ lb Hand	2210	.124	45.54	.183			
	Ladle	2120	.112	39 44	.185			
	Gain	90	.012	6.10		4.2 %	10.7 %	15 4 %
Nov. 18, '05	1 lb 200 lb	2370	.139	54.76	.186			
	Ladle	2050	.118	40.19	.184			
	Gain	320	.021	14.57		15.6 %	17.8 %	36.2 %
Nov. 21, '05	1 lb 200 lb	2178	.128	46 34	.188			
	Ladle	2000	.119	39 60	.182			
	Gain	178	.009	6.74		8.9 %	7.5 %	17. %

MANUFACTURE OF SOIL PIPES AND FITTINGS.

BY T. J. BEST, MONTREAL, P. Q.

The first requisite in the art of making soil pipes and fittings, is a well lighted and ventilated foundry. A shop 86 by 200 feet will be required for a melt of from twenty to twenty-five tons per day. Light should come from each side and end. Also one or two monitors running nearly the full length of the roof, wtth pivoted sash duly placed in them. This will make the center of the shop nearly as light as at the sides. Perfect ventilation will also be assured.

The mill, or cleaning, chipping, and oiling rooms, should be at one end of the foundry, with a fire-proof wall between the two. The mill room should be large enough for twelve to sixteen ordinary mills. If, however, exhaust mills are used, a smaller number will answer.

The floor plan of the foundry could

be laid out as follows:—On the side nearest to the cupola, a passage about six feet wide should be arranged for, extending from end to end. Then the pipe floors are laid out, each about eleven by forty-five feet. The floors should run cross-ways to the foundry, and then another passage of five feet laid out, also extending the full length of the building. There should be a good wide passage in front of the cupola, which should connect the longitudinal passages together. In the center of each passage, a narrow-gauge industrial railway should be laid down, and provided with proper turn-tables at each end and at the center passage. This railway should continue through the mill-room.

The mill room should be about twenty by eighty feet, the mills to be placed on each side. A turn-table should be placed so that work may be taken from the mills when clean and sent to the chipping and grinding room. From there it should be continued to the oiling room, and thence to the shipping sheds.

In the center portions of the pipe floors, at proper distances apart from each other, there should be set and secured firmly iron rails, or small I beams, in order to rest mold boxes and machines upon them. In the center of the passage between floors, Tee irons should be suspended from the roof, well stayed, and high enough to allow men to walk beneath them. This is for the purpose of resting the mold boxes against them while on end, after the heat has been poured, and the boxes shaken out at night. A good supply of trucks is essential to carry out the castings either by night or day, as may be desired. In any case a few men with good trucks can clean up the foundry very quickly.

The machines, or follow-boards, on which the pipes are made, as well as size and weight of mold boxes, vary in different establishments. Some foundries use machines run by steam, others use hydraulic power, or compressed air, to press the mold. The general way, however, is to do the work by hand ramming. The pattern, or patterns, should be made very accurately, and be well fitted. I have seen patterns made with rather more than half circle and finished with files and emery cloth. This is a tedious and crude way of making patterns. By all means see that good sound castings are provided, and turn them up. If you have a universal grinder, finish your patterns by grinding them. Too much care cannot be given the machines and patterns. The plates and stops for mold boxes must be accurate. The mechanism for raising and lowering patterns should be as simple as possible, with the precaution that the patterns should be raised vertically only. I have seen cam motions that would lift patterns slightly side-ways, while others would lift toward one end. This is liable to make an overlap one way or the other. Patterns for two-inch and three-inch pipe are made two in a box. In many places the four-inch are also made two in a box, but with a single pattern and a light box, one man can make thirty-five and in many cases forty-five four-inch pipes a day, if two men are working together. Another advantage is that when one man rams the mold it will be uniform, two men working on a mold will not ram up the same, and the result is an uneven casting. Good results are obtained with one man on a floor, and the understanding that the men lift for each other, and also help set the cores.

The light pipes should be made in the center of the shop, so that the hottest iron may be poured there. The heavier material can be cast at the ends of the foundry, and the metal taken there in small bull-ladles holding five to six hundred pounds, on an over-head system. This will save a lot of hard work.

The fitting floors can all be stationed at one side of the foundry, or in any other part not taken up by pipe floors.

All fitting patterns should be well finished and set true in follow-boards. The four-inch Tees, as well as all other small patterns are made two in a box. This refers to shell patterns. I have seen a man make eighty four-inch elbows in a day, but both patterns and follow-boards must be first-class to do this.

Follow-boards and patterns must be kept clean. The boards should be well coated with shellac varnish, and patterns with a composition to prevent rust. For this purpose a good article consists of four ounces sperm wax, and four of bees-wax, melted together. Benzine is added as well as plumbago to make a stiff paste. Put this on the patterns with a paint brush and polish with an ordinary stove brush. A boy can keep quite a number of patterns in good condition. Molders can and will make more and better work when they have the best of patterns to work with.

The pattern storage is another important thing. The mold board should be given a letter or figure. A corresponding letter or figure should be placed on the rack or shelf on which the pattern is to be kept. The storage should be well ventilated and lighted. Fire-proof doors and shutters are necessary. These may be expensive, but will pay in the end. All pipe patterns should be cleaned off every day, and the mechanism oiled. It will not take long to do this, but if neglected, will soon run up into money.

There should be a plentiful water supply. Six or eight water barrels set on the floor will be of great benefit to the men. It will enable them to drink, and wet the core boxes and bars as required, without walking a long distance.

Sometimes there has been difficulty in pouring the full heat. A good plan is to train every man to carry iron. Every laborer should be given a ladle full of the first tap, and be made to carry it to some part of the shop and dump it into a conical pot. Of these there should be quite a number throughout the foundry. Putting the iron into them is far better than spilling it on the floor to be gathered up next morning. Nice clean ingot scrap is the result, and no sand or dirt to go into the cupola. If every new man is trained as above mentioned, there will never be trouble to have men on hand to take away the full heat.

We have to turn out a better grade of pipe and fittings than formerly. I do not know how it is with you in the United States, but we in Canada are forbidden to use the broad mantle of charity that covers a multitude of sins, that is to say—the hot tar-pot. Our pipes and fittings must be oiled, or dipped into a mixture of oil and benzine. The oiling room should have two or more tanks into which all pipes and fittings can be immersed. Also suitable drainage racks on which pipes can be stood on end, the surplus oil running back into the tanks. The fittings are dipped and thrown on a drainage rack. Racks about two feet apart and as long as convenient may be set up, bars of three-quarter-inch pipe being placed about every two feet apart to form pockets or divisions. This will prevent the oiled pipe from falling over, and by the time the rack is filled, the first pipes will be ready to go to the shipping room. Some foundries dip their pipes on the side, while others dip on end. This may be carried out just as desired or convenient.

Pipe Cores.—There are various ways of making cores. They are now, however, usually made of green-sand. Some do their ramming by hand, others by means of squeezers; and still others in vertical core boxes made in three parts. In the boxes the back part is held stationary, and the other two parts are hinged to it. The core-bar is whetted and put into position. Then a tube, having a screw with a coarse thread at the lower end is lowered over the core bar, a small quantity of sand thrown in, and the screw re-

XUM

volved by machinery. A man throws the sand into the hopper, and as the screw revolves, it packs the core which raises itself the same time. There are balance weights on a chain which regulate the pressure put on the sand in the box. This machine is very good but also very expensive, and is being superceded by the horizontal machine. There are a great variety of these machines. For instance, I have seen a long riddle suitably suspended to sift the sand down on a core bar. The noise of the mechanism could be heard a long way off and was very annoying. Others are made with a shaft on which a number of wheels are made to revolve, and thus shake the sand on the bars. Whatever the style, the bar revolves and the sand falls on it from above. As the sand impinges, it is rotated against the steel knife provided and shaped for the purpose. From five to six hundred cores can be made and used each day on a good machine, in sizes from two to six inches in diameter. The change from one size to another can be made in a minute.

Cupola and Melting.—We read and hear so much about high and low melting ratios. The trouble is that we do not take time to think deeply enough about our business. For instance, not long ago I read of a foundry having a 52-inch cupola melting about 20,000 pounds a day, at a ratio of six to one. They could not understand why others were getting better results. I do not pretend to know as much about what I have given here as I ought to, yet I do say that if we want to be successful, we must proportion things properly. Therefore, for a plant such as I have described in this paper, in which from twenty to twenty-five tons a day are cast, the cupola should measure about forty-five inches inside the lining, which should be double brick. At least six tuyeres four by twelve inches should be arranged for. The main blast pipe to be eighteen inches diameter, and if convenient let down each side of the cupola in two thirteen-inch pipes. The blower, which I prefer to be a positive one, to be as near the cupola as convenient. In this way from three thousand five hundred to four thousand cubic feet of air will be furnished each ton of iron melted, and there will be no difficulty in getting a ten to one ratio. It must be borne in mind, however, that it is as important to look after the coke as any other part of the melting scheme, and suitable dry sheds should be provided for it as well as the sand.

For pipe and fittings the metal required should be both hot and clean. In order to have this, let the melt be as continuous as possible. A convenient ladle should be kept under the spout, and when the metal is first tapped it should not be stopped again during the whole pouring operation. The tuyeres for this class of castings should be placed lower than where iron is held in the cupola. In order to get rid of the slag, the spout should be made special as follows:—About one-half down the length of the spout an opening should be made in one side, and about four inches ahead of this opening there should be inserted a fire brick on edge, so as to form a trap or depression under which the iron must pass or rise to about the same level again on the other side of the brick. Then the slag, which is lighter than the iron, will flow off at the side opening, and can be led to any desired place. It will be advisable to cover that portion of the spout nearest the cupola. Keep a little wood or charcoal floating on the slag. This will keep it hot, and ensure its flowing easily, at the same time keeping your iron clean.

THE CORRECT APPLICATION OF TRUE BURDEN TO IRON COSTS.*

BY E. M. TAYLOR, BOSTON, MASS.

Mr. President and Gentlemen:—The subject which we have chosen for discussion covers such a multitude of sins, that is, business sins, which it has been my fortune or misfortune—sometimes I am inclined to think one way and at other times the other—to encounter in the several sections of this country which I have visited, that it may be best at the outset to make the tail wag the dog; that is, to define what "true burden" is, and then to treat of its "correct application" to first or prime costs.

A burden is a care, a worry or a trouble, an indefinable something which deepens the lines in our foreheads, a something which we are constantly trying to reduce to tangible form so that we may look it straight in the face and devise ways and means to throw it overboard or to master it before it has brought us down to mother earth in ignoble defeat.

Burden in a business sense is broadly speaking, "Expense," and "true burden" is the simple reduction into a lump sum of dollars, every conceivable dollar we spend which for any reason whatever we do not think best to attempt to apply as a part of the first or direct cost of any pound of castings we manufacture or produce.

It is the duty of every foundryman, large or small, to know what this Burden is which he is carrying, and there is no excuse today for the man who does not know.

Furthermore, in order that your business Burden may not get the best of you and in order that you may be sure that you are unloading your Burden on the customers for whose benefit you operate your plant, you must know at the end of each month what your Burden has amounted to.

To get these facts you must analyze your pay roll carefully into the general classes: productive and non-productive labor.

This means that every time one of your producers, say a molder, is called away from molding work to assist in repairing the cupola, the buildings or equipment, you must charge the time so consumed to Burden. Likewise all other labor which you cannot attach directly to the cost of each casting produced must be included in the Burden.

The same general principle applies to materials. And there are very few materials which may be classed as directly productive; that is, which may be easily measured and applied to each individual casting. Therefore practically all materials except the iron melted must be included in the Burden.

And in determining the quantities consumed each month, ways and means must be devised which will assure an equitable distribution. That is, if you buy coal in quantities to last three months, you are not justified in distributing the entire amount of the invoice into the Burden of any one month.

When you have treated your pay roll expenditure properly, and have made an equitable distribution of materials consumed, you must add certain amounts to cover taxes, insurance, depreciation, etc.

The grand total will represent your gross Burden expenditure for the period, and you are then in a position to handle the questions of distribution to prime costs, overhead costs, and profit or loss, in an intelligent manner and without gloves.

You have passed from the stage of blind guess to that of known facts, and if for any reason you sell at a loss you must do it gracefully and with malice aforethought.

To digress for a minute, let me recite the effect which this Burden question is likely to have on the mind of man.

It was my privilege to be called in

*Note.—This paper was read before the New England Foundrymen's Association, May 9, 1906.

consultation by a very able man engaged in the manufacturing business.

We spent the greater part of one day and up to about ten o'clock at night in strenuous argument over the proper items to put into his Burden, and he occasionally remarked that he didn't like that word Burden any way. The session had been lengthy and got on our nerves to a certain extent.

Several days later I saw the gentleman and the following conversation ensued:

"Young man, I've got a bone to pick with you. You remember the talk we had the other day. Well, when I reached home my family had all gone to the theater. I was tired enough to turn right in, but I didn't sleep very well.

"The next morning my wife asked me if I had anything on my mind, if anything in particular was worrying me. I replied 'no' and asked her why she wanted to know. 'Well,' she said, 'you know you were very restless last night, and talked in your sleep, and your language shocked me,' and finally she told me that one remark she clearly understood was 'Well, what in h—ll has that got to do with the Burden?' "

Now, gentlemen, so much for the Burden, and I must say that if a few hours conversation on the subject will create such an impression on a man's mind there must be something in it.

The next problem is how to apply these Burden dollars to prime costs, so that when we sell we will know whether we are getting our money back or not.

You must develop by the proper monthly cost reports what the Burden rate per hour is. That is, you must divide the gross Burden expenditure by the number of hours which have actually been put into productive work, or if for any reason it is not practical to get these hours you must develop the percentage which the Burden dollars are of the direct labor.

In other words, the Burden dollars must be distributed according to the length of time a casting is in process and not according to the weight or cost of the material used to make the casting.

To illustrate:—you start two molders to work, No. 1 on a fly wheel pattern, and No. 2 on a small intricate cylinder pattern. No. 1 completes the job in five hours and gets a casting weighing nine hundred pounds. No. 2 completes his job in five hours and gets a casting weighing one hundred pounds.

Now suppose our total Burden expenditure during the ten hours has been ten dollars.

Molders No. 1 and 2 have therefore produced one thousand pounds of castings during a period of ten productive hours at a Burden cost of ten dollars.

Now if we distribute the ten Burden dollars on a basis of pounds, the Burden rate per pound is one cent, and we would apply nine dollars as Burden cost to the fly wheel and one dollar to the cylinder.

But our cost of taxes, depreciation, supervision and all other Burden items has been accumulating during the ten productive hours entirely without regard to our feelings or to weight of the castings being produced, which means that our Burden rate per productive hour has been one dollar and we have used up five dollars' worth of Burden cost during the time taken to produce each casting entirely irrespective of the weight of either casting.

This is the true Burden cost, and shows that on the per pound basis we have fooled ourselves to the extent of four dollars too much on the fly wheel casting, and to the extent of four dollars too little on the cylinder casting.

These, gentlemen, are the facts in regard to the "correct application of true Burden to iron costs." No foundryman can afford to operate on any other basis, and I will be very glad indeed if this brief address is of assistance to any of you.

A TALK ON ALLOYS.

BY C. VICKERS, MILWAUKEE, WIS.

The metals most frequently alloyed with copper are: tin, zinc, and lead. Those less frequently used are: antimony, silicon, aluminum, manganese and nickel.

Alloys of copper with tin are known as bronzes. It is rarely, however, that copper and tin are used alone to form bronze, small quantities of zinc and lead being generally added for specific purposes, thus zinc promotes solidity, or freedom from blow holes while lead makes the alloy more easy to work. Bronze is the most useful of the alloys of copper for casting purposes, and in spite of the high price of tin, there are few founders who can dispense with it altogether.

Copper and zinc alloys are known as yellow brass, to the trade, the adjective yellow being prefixed to distinguish them from the bronzes, which are generally known by the term "red brass."

Yellow brass is largely used for casting purposes, in the making of plumbers' brass goods, gas and electric fixtures, hose couplings, nozzles and the like.

Zinc may be added to copper in much greater quantity than tin, and form a useful alloy. The limit of usefulness being equal parts of copper and zinc, which forms spelter solder.

When the zinc exceeds the copper the alloy rapidly whitens in color and becomes brittle and worthless at 65 per cent zinc, 35 per cent copper, one per cent aluminum. The alloy is a brilliant white metal which may be easily pulverized in a mortar.

All alloys of copper high in zinc are much improved in casting qualities by the addition of aluminum. When heated some of them become very plastic and can be worked into complex shapes. Externally they have a beautiful yellow color tinged with green, and when soiled, may be restored to their original beauty by heating to faint redness, and quenching in water.

An alloy of eleven parts copper, nine parts zinc, and one per cent aluminum while externally of the yellow color mentioned, resembles red brass when cut into. It is a very rigid, and highly sonorous alloy.

The proportions above, must not be deviated from, however, otherwise in place of the high tensile alloy, we obtain an alloy, which, while pretty, is worthless when strength is required. It is characterized by a brilliant greenish yellow, crystalline fracture, and has the strength of cast zinc.

Alloys of copper and lead are known as pot metal. Such alloys are now obsolete, therefore, we will pass them by without further notice. Lead, however, is extensively used in copper alloys. A good bearing alloy being copper, 80 parts; tin, 10 parts; lead, 10 parts; lead is also used with zinc to form "red brass" proper. A typical red brass alloy is copper, 50 parts; lead, five parts; zinc, five parts; tin, two parts; this is a very useful alloy for small castings, as it may be easily machined.

The use of antimony in copper alloys is limited as it makes the alloy brittle. An alloy of copper, 10 parts; antimony, 2½ parts; is close gained, similar to bell metal and takes a high polish, but is very brittle. Copper, 20 parts; antimony, 2½ parts; is a red metal. A test bar one-half inch square, and twelve inches in length supported at each end, broke under a load of 140 pounds, applied at the center. Before breaking, it was deflected one inch from a straight line. An alloy of antimony, 3½ parts; zinc, 2¾ parts; is a close grained white alloy, useful only as a mixing alloy; it is so brittle it may be powdered with ease.

Two parts of this alloy were added to 16 parts of copper, a test bar of this metal one-half inch square and 12 inches between supports, under a weight of 140 pounds, was deflected two inches without breaking.

Castings of this alloy, come out of the sand coated with a white deposit, precisely as if heavily tinned, and on that account it is interesting.

Antimony can be used to harden copper, without materially changing its color. An alloy of copper, 10 parts; silicon copper, one-eighth part; Antimony, one-half part; is hard, tough, sonorous and useful for many purposes where a hardened copper is required.

Silicon is used in copper alloys as a deoxidizer; one pound of silicon copper will deoxidize 100 pounds of casting copper, and make perfectly solid castings, it is much better for this purpose than phosphorus, as the castings run clean and bright.

Copper aluminum alloys are difficult to cast; on this account they are not much used by brass founders, and the same may be said of manganese while nickel is used in German silver and other kindred white alloys. Of all metals used to alloy with copper, tin is by far the best; its place can be filled by no other metal. All alloys of a red color, in which tin is omitted or only used in small quantity, are imitation bronzes and resemble true bronze only in appearance. They have their own sphere of usefulness but can never take the place of bronze on heavy machinery.

DARK SECRETS IN FOUNDRY PRACTICE.

BY WM. H. PARRY, BROOKLYN, N. Y.

In these latter days we are becoming quite accustomed to congratulate ourselves on our wonderful progress. In many lines of endeavor this is certainly true; and while the foundry practice of our country will more than compare favorably with that of any other nation, yet there is a tendency, in some quarters at least, to throttle progress by guarding trade secrets (?) for fear of financial ruin.

Let us consider a few practices in foundries still prevalent, from the viewpoint of a looker-on, rather than as a foundryman. In Hoboken, N. J., last June, there was given an exhibition of a new method of making gray iron castings in iron molds. This statement in itself is not startling, for it is done frequently enough. But in this case the castings when cool enough to handle were also soft enough to drill and file. In this particular instance the castings were four-inch soil pipe elbows, averaging a quarter of an inch in thickness. The mold in question was a three part affair, the two upper portions being hinged to the lower, and making between them, when closed, the outer form of the elbow, and space for the sprue and riser. A green sand core was used with an arbor designed to set firmly at the ends of the mold.

Just previous to the commencement of casting operations, the mold was coated with a mixture known only to the inventor. Then the mold was heated long enough from the inside, by placing sows from the first tap of iron, until the heat penetrated to the outside. All dirt was blown out, and the third act of the comedy took place. This was the application of another coat of liquid, which it is hardly necessary to state was also a dark secret. The green sand core was placed in position, the mold closed and locked, iron poured in, and in a few minutes the mold was opened, the sprue and risers knocked off, and the casting taken out. The operations were then repeated several times, with the exception that the mixture was not used, this being guaranteed to last a day.

An examination of the castings showed that at the farthest point from the sprue, at the outside, were innumerable cold shuts; in fact, the castings were not by any means first-class, though this was the very thing claimed for the process.

In this, as well as many other attempts to improve foundry methods, the practical side was entirely lost sight of by the promoters. Supposing

the mixtures and liquids were all that was claimed for them, the use of the iron molds would be limited to repetition work of the simplest kind anyhow. Their relatively high cost, and possible short life due to distortion, would not tend toward economy, and continuous melting and a plentiful supply of molds would be necessary, to say nothing of the fact that the core had to be made in the ordinary way.

It seems a pity indeed that the ingredients of the twin liquids are not known for our edification, and that a harder iron than the one used was not taken. With the iron running silicon 2.34, sulphur 0.07, phosphorus 0.280, manganese 0.44, combined carbon 0.26, graphite 3.27, it will be seen that with a hot iron mold, likely coated with powdered aluminum, and a regular green sand core, an iron of this composition could not come out hard, whatever its physical characteristics due to casting into a metal mold.

In the diamond polishing industry, a small proportion of which this country is permitted to share with Belgium and Holland, through the importation of operators and material from those back-number countries; there is a little item in foundry practice that is worth while delving into. Not because of its commercial value, which is nil, but rather to show up a foundry octopus in this age of trust exposures.

All diamond operators are united in the belief that the metal disks used for cutting and polishing diamonds can only be made in Holland or Belgium. For they naively say, the secret of the composition has been kept in certain families for centuries. The disks in question are about 11½ inches in diameter, and ⅝ or ¾ inch thick, and are rotated at a very high speed in a horizontal plane. The upper face is smeared with a mixture of olive oil and "bort" or diamond dust. The stones to be polished are placed about this disk, weighted, and in due time are ground down to the desired shape.

It is conceded that the best wheels are made in Antwerp, by DeWinter & Son, and an analysis shows that all that is required is a good grade of open-grained cast iron. The necessity for the open-grain is to provide minute pockets for the lodging of the diamond dust while performing its functions. In other words it is a case of "diamond cut diamond." Perchance some day a member of the American Foundrymen's Association may be called upon to specialize in diamond polishing wheels, so here is the analysis of the castings:—Silicon 2.70, sulphur 0.063, phosphorus 0.302, manganese 0.44, combined carbon 1.60, and graphite 1.37.

In making castings that require a chilled surface there appears to be a lack of knowledge, or at least a lack of the desire to part with that knowledge on the part of those individuals who may be fortunate enough to possess it. There should be determined once for all what results are obtained from a given mixture cast at a given temperature and against chills of a certain thickness, with the range due to variations in each. This problem does not seem impossible of solution and the tables thus constructed would be invaluable.

Having some experience with chilled work on small castings where the chills were used solely to insure solidity at a certain spot, the statement was made to me by a foreman to whom complaint was made—that the last lot of castings were porous—that the chills were probably too old. Upon investigation it was found that the chills were free from fire-cracks, and otherwise in good shape though used intermittently for some twenty years. Drillings taken from the side of the chills on the contact side gave:—silicon 2.07, sulphur 0.073, phosphorus 0.0312, manganese 0.48, combined carbon 0.23, and graphite 2.41. From these figures it would seem that while the chills were almost old enough to vote, that were not decrepit by any means.

XUM

To Mr. H. E. Diller, the secretary of the Metallurgical Section of the American Foundrymen's Association, is due the credit for the analyses generously contributed by him for this paper.

MOLDING PROBLEMS.

BY DAVID SPENCE, FRANKLIN, MASS.

There is no industry that offers so wide a field for thought as the iron foundry. I started out as a foundry foreman when quite young, and one day the proprietor came along with a pulley pattern, 12-inch face, and 24-inch diameter. This he wanted used for a casting with a 16-inch face. After studying it over a while, I gave it to a careful molder with the following instructions:—I had him put the pattern on six blocks, two inches high, and tuck the sand under the arms and hub. (It was a split pulley pattern.) Next he made his parting and placed the other half of the pattern on, ramming up the cope. After the cope was lifted off I had a wooden frame ready, this being the size of the flask. I had this screwed on the joint of the flask two inches deep, and again pulled up the other half of the pulley two inches and tucked under the arms and the hub, the same as in the drag. Great care was taken to nail the cope well, so that the two inches added would not drop off in closing the mold. I had good slides put on the flask, so that there would be a perfect joint, and the result was a good 16-inch face pulley casting.

While learning my trade, I saw a molder making a pulley eight inches in diameter, and 12 inches face. The pattern had a web instead of arms. I saw that he had a lot of trouble with it dropping. When he did get a good mold it would blow, and thus quite a number of castings were lost. I told the foreman that I thought I could overcome the difficulty, and had two pieces of pipe made by a tinsmith six inches in diameter and 10 inches long each, and also provided with a flange on one end. I had the tinsmith perforate these pipes on the side. I put the first half of the pattern down on the board and sieved a little sand on it. Then I placed my sheet iron pipe on the web and rammed it up carefully with a small wooden stick. After ramming it, I vented it well beside the iron pipe and then put on a good bottom board with a number of small holes in it to take off the gases. I then turned it over and put on the other half of the pattern, put on the cope, and rammed it up in the same manner, using great care in venting. When I drew out my pattern, finished the mold, and closed it up, I had no trouble from dropping, as the flange on the iron would not let it do so. I cast my pulley and had no trouble from blowing, using this method ever since, with good results.

I was starting up a new foundry in a small city where a great deal of sawmill work was done. Before I had the core-oven built and the crane in, a mill-owner came with an order for a large pulley, 6-inch bore, and to be done at once. As I did not have a 6-inch core box made yet, and could not have dried the core if I had had it, I began thinking very quickly, and finally went again to a tin shop, got a pipe six inches in diameter and of proper length. I took this to the foundry and rammed it full of green sand and vented it properly, and next morning when the casting was turned out, it had a good smooth hole.

In one of the foundries I am running at present we have been doing a lot of mill work, and among this quite a quantity of large sprocket wheels with heavy rims and hubs. These would crack in the arms on account of the bad proportioning of metal in the design. To overcome this trouble I arranged to have the cope shaken out on the casting, and to bare the sand off the hub and the rim, leaving it on the arms. Then I had a ring made in the sand, and

XUM

poured in melted iron. This held the heat in the arms as long as in the hub and rim.

The few instances outlined in the foregoing will show that what we want our young men to do is to think. It is the aim of our association to stimulate this thinking on the part of its members, and thus to build up our industry within as well as without.

FOUNDRY TESTS OF COKE MADE BY THE U. S. FUEL TESTING PLANT AT ST. LOUIS.

BY DR. RICHARD MOLDENKE, WATCHUNG, N. J.

At the suggestion of Dr. J. A. Holmes, chief of the Mines and Metallurgy division of the St. Louis Exposition, the American Foundrymen's Association, in convention at Indianapolis, authorized the appointment of a committee to carry out a series of tests on coke made in the fuel testing plant of the government on the exposition grounds. This committee consisted of Messrs. H. E. Field, of Pittsburg, W. J. Fogarty, of St. Louis, and R. Moldenke, of New York. Mr. Field, who is a specialist on cupola practice, outlined the plan of the tests, while the writer conducted the actual tests on the ground.

The coke it was proposed to test was made in connection with the tests of the government, on the miscellaneous coals sent from all over the country by those desirous of learning their comparative value for steaming, gas making, coking and briquetting purposes. Whenever a coal would coke, and showed some promise of being useful for the foundry, it was kept for these tests. In this way nineteen tests were made, and at the present writing some one hundred and forty more await trial. The work is to be continued right along, subject to the action of Congress, and unquestionably the industries of the country will be the gainers by continued support on the part of the government.

The method adopted for the tests will be seen in the following:—All materials were accurately weighed and charged. No estimating or measuring was done. The iron was uniform in composition and size. The scrap was made during the tests, and was cast into pigs of uniform size. The same proportions were used for all tests, and the cupolas were charged in the same way for each test, being put into the same condition daily. Tests were made consecutively, and the weather conditions remained identical throughout the work.

The records kept were as follows:—Identification of sample. Charge in detail. Time of putting on blast. Time of first iron. Time and weight of every ladle of iron. Melting rate per hour. Temperature of iron as measured by fluidity strips. Melting loss. Analysis and characteristics of coke. Characteristics of test and conclusions derived therefrom.

It is always difficult to get a fair sample of coke for analysis. For these tests, inasmuch as the coke was made but a step from the foundry, it was easy to get four pieces taken from different parts of the oven, each piece extending from top to bottom. From these the analysis was made. A proper relation of carbon and slate was thus preserved, and the analysis would show much of value before the actual test was made. In fact it enabled the exclusion of those cokes, which on account of their sulphur or excessive ash, would not be practical for foundry purposes.

The following was called for in the coke. Phosphorus, volatile carbon, fixed carbon, ash, moisture, total sulphur, and sulphur in the ash, the specific gravity, and the crushing strength. The appearance was further judged and valued for the benefit of the foundryman who is not yet educated to the point of taking a coke on the merits of composition, regardless of its appearance. In this comparison, Connellsville coke was taken as the standard.

In order to use a coke properly, it must be studied from various standpoints. If the cupola is provided with low tuyeres, and long heats are the rule, it is necessary to use a heavy coke to hold the melting zone at the proper point. A light coke, even if strong enough to bear the burden, would burn away so fast that the melting zone is lowered too much, and the result is burnt iron. The same coke, on the other hand, with a high tuyere cupola would answer first-class.

Cokes should therefore be divided into two classes, and recommended according to their density. The heavy ones for low-tuyere cupolas, and the light ones for high tuyere cupolas, a point that might well be remembered by the coke salesman, who wants to please a customer.

For the purpose of these tests it was impossible to discriminate, as the two small cupolas used (one from the Whiting Foundry Equipment Co., and the other from the J. S. McCormick Co., both identical in dimensions, and varying only in their detail) had their tuyeres fixed. As the cokes were nearly all of the light varieties, and previous tests with the cupolas had demonstrated the desirability of keeping a pretty thick bed, the upper tuyeres were closed, and a constant height of 14 inches above the lower tuyeres was adopted. The blast was held at seven ounces as nearly as could be managed, a small cupola with the lighter varieties of coke not running well with more pressure.

The melting ratio was selected at 1 to 7 arbitrarily. It is somewhat severe for the light cokes, but makes a very fair average for a small cupola in a series of tests. In charging, the fire was made the usual way, coke being added until the wood was burned out, and the coke well ignited. Charging was then begun and completed. Before the first iron was thrown on, the height of the coke bed was measured with an iron rod having a flat weight attached. The height was brought up to the proper level by adding coke, so that the tests might be comparable.

3,000 pounds iron, 2,250 of this being pig iron, and 750 pounds scrap made in these tests, and of uniform size and weight; was the amount of metal used in each test. The coke was 430 pounds or one to seven. On the bed of coke, the weight of which, after being brought to the proper height, was subtracted from the 430 to be used; a charge of pig iron and scrap in proper proportions was next put on to run one to four with the coke. The rest of the pig iron, scrap, and coke was then divided into four charges and placed in the cupola as usual. Thus for the first test made, the bed consisted of 220 pounds coke, and 660 pounds pig iron and 220 pounds scrap, or 220 coke and 880 metal, or one to four. Then came four charges of 54 pounds coke, and 398 pounds pig iron and 132 pounds scrap.

It will thus be seen that the ratio of 1 to 7 was kept throughout, but that the proportions of the charge would vary from test to test, according to the density of the coke taken. A dense coke would have a heavy bed, and lighter subsequent charges, while a light coke would reverse these conditions. The iron used was of a composition corresponding to a No. 4 and came from the south.

It may be argued that to get a proper test of a coke, the cupola conditions should be arranged to suit it, and not the way it was actually carried out. As a matter of fact, the tests being made on the coke, and not the iron, blast, or any other item of foundry practice, all things had to be made constant, whether this suited the coke or not. If, then, the results showed promise, even if not perfection, the coke could be recommended for further trial. Where a coke was absolutely unfit for the foundry, it would be quickly seen in the tests, and the coke condemned for this use. It is left to the owners of the coal which produced the coke in question, to make further

XUM

tests with their coke in the foundry to demonstrate to their own satisfaction, just what conditions in the cupola are necessary to give them the best results. This is a commercial matter with which the government has nothing to do, the demonstration of which showed the adaptability of the coal received for coking and foundry purposes, in addition to the other tests for gas and steaming, etc., being all that can be reasonably required as a public work.

For purposes of comparison, tests were also made with standard cokes during the series, in order that there might be no question as to the practicability of the system employed. These standard cokes were the well known Frick Connellsville seventy-two hour, (the car load donated to the government for this work was about the finest I ever saw); Milwaukee Semet-Solvay Byproduct; and the Gauley Mountain coke to represent the West Virginia field. In the series to be made hereafter, there will be added the Mount Carbon Co.'s Powellton coke, and perhaps several others as additional standards for comparison.

The results of the tests are published by the U. S. Geological Survey, and will interest the owners of the coal more than the general foundry public. Much of the interest can, however, be extracted by us and applied to our daily operations. Thus, in the very first test, on a rather light coke, the bed was burned away so rapidly, that the melting zone came down far enough to allow a direct burning of the iron. Great quantities of slag were formed, the slag spout could not take it away, the tuyeres were filled up, and bottom had to be dropped. On weighing up the material next morning, it was found that over half of the iron had actually burned up, and passed into the slag. The melting loss was 52.5 per cent. This is a commentary on what occurs daily in our foundries. No matter how carefully the melting operations in the cupola may be conducted, there will always be more or less burning of small particles of the metal as it drops down through the bed. Unfortunately not all of this oxidized metal passes off into the slag, but dissolves in the melted iron. Hence weak castings. In the case above mentioned, the coke was plainly at fault, though other cupola arrangements might have saved much of the iron. The moral of the story, however, lies in the necessity for watching carefully whether your practice in the arrangement of the coke charges, blast, etc. is such that only a minimum of this burning takes place.

Taking the melting loss of all of the heats made, we find that the minimum was 3.2 per cent, made on a coke very close in resemblance to the Connellsville product, but lighter. The three standard cokes gave a melting loss of 6.8, 8.2, and 10.3 per cent, which is high, and due to the smallness of the heat, and comparatively hard iron used. The average of the good cokes tested was 10 per cent while the bad cokes ran up to 25 per cent.

Another interesting point was to note the time it took to get the first iron. It took five up to fifteen minutes, after the blast was put on. Where the iron came quickly, and the coke was of good composition, excellent foundry results were obtained, the charges evidently having been suitable. In the case of the coke taking fifteen minutes for the first metal to appear, this was an exceedingly heavy coke, and the bed had to burn down to the proper point, before the pig was melted. The result naturally was that the upper charges of coke were comparatively too small, as too much went into the first bed, and the heat could not be completed. The coke having 15 per cent ash, in any case would make its use problematical in the foundry. The lesson for us to learn from this test would seem to lie in watching how quickly your iron shows at the spout, if you keep the tap-hole open, in order to note whether the coke bed is too thick or not. There

is no economy in putting on an extra heavy bed of coke, in order to have to wait until it is burned down low enough to let the iron get to the melting zone.

A number of other little points might be mentioned, but the above will be sufficient to show that these tests are not only valuable in determining the utility of coals other than the standard coking ones, for making foundry coke, but also in giving an opportunity to run a lot of material the ordinary foundryman would not look at, through the cupola, and getting the experience this brings without ruining castings.

In conclusion it must be mentioned that while these tests were conducted by the writer personally, much of the success belongs to the faithful and enthusiastic services of Mr. A. E. Sauerwein, who was in charge of the foundry at the St. Louis exposition where these tests were made.

UNIFORM PRACTICE IN FOUNDRY COST FINDING.

BY KENNETH FALCONER, MONTREAL, P. Q.

To a certain extent I have accepted your secretary's kind invitation to submit a paper to this convention, and to meet in Cleveland the members of the American Foundrymen's Association under false pretenses, for I am neither an American nor a Foundryman. These are misfortunes not faults, which I have to some degree overcome, inasmuch as I have the happiness of having an American wife, and the honor of belonging to the American Foundrymen's Association.

The saying that this is an age of "Specialism" is so common as hardly to be worthy of repetition: that it is an age of standardization of methods—of uniform practice—is equally true, though less frequently stated, and perhaps less generally recognized. The existence and growth of associations of those whose work is similar, or whose interests lie in the same direction is in itself an evidence of this: the logical influence of conventions and meetings of such organizations is towards the general adoption of certain principles, the details of their application being subject to individual conditions and special requirements. As a result of this convention, different members of this association will, during the coming year be thinking along similar lines, and adopting, in relation to certain features of their business, similar methods with similar ends in view. It may be possible that some degree of uniformity in cost finding methods in different foundries, and in different plants, whose interests are represented here, would result in general good to the trade. The Steel Founders Society of America, have in the recent past, taken up the subject of "Uniform Methods of Cost Finding for Steel Foundries," and those connected with each line of manufacture, or interested in each branch of industry might possibly consider with benefit the advisability of adopting in their different plants methods of Cost Finding uniform in so far as general principles are concerned, though possibly widely different in details.

"Competition is the life of trade," but this is only true in so far as it relates to intelligent competition, based on accurate knowledge of the results of previous operations and transactions. Unintelligent competition based on guesses of costs or on rumors of competitors' prices is the ruin of trade, and the death of industry. Uuprofitable business is frequently accepted with full knowledge of its undesirability, but in the majority of cases such a course is necessitated because some other concern has submitted a quotation based on incorrect and misleading methods of Cost Finding and of estimating. A long step will have been taken towards eliminating such competition in any line of manufacture if the basic and underlying principles of Cost Finding, which are properly applicable to such line of manufacture, be uniformly adopted, the details con-

nected with the application of such principles being worked out to suit individual conditions and circumstances.

It goes without saying that no system of Cost Finding can be designed for the manufacture of castings, or for any other business applicable in all its details to the plants of competing concerns, but the fact remains that similar principles of Cost Finding, and the broad application of such principles on similar lines are applicable in all plants manufacturing similar products, and the resulting influence will make for healthy and normal competition, instead of disastrous rivalry.

To standardize methods of costing and estimating in any industry, a clear understanding of the term "Costs" as applied to manufactured product is essential. To some it means only the value of material and labor consumed, to others it includes expenses incurred in running the plant, while the elect take it to cover in addition all expenses of selling and of administration, and in some cases all possible outlays.

While the division of each plant or organization into its component departments might involve in each instance different definitions of departments and limitations of authority, it would make for more intelligent estimating for competitive purposes, if competing plants were departmentalized in the first instance on similar general lines. All the departments of a productive organization are, naturally, capable of classification as manufacturing, selling or administration, this logically resulting in three costs, which may be defined as cost manufactured, cost sold and final cost. If all bids and tenders were based on accurate knowledge of these three costs, members of the trade interested would, to a greater extent than at present, have only fair and legitimate competition to meet. The methods of obtaining records of labor and material costs would necessarily be determined in each plant by the individual judgment of those in control, as would also all other details of cost work. Cost of material is practically governed by market conditions, and cost of labor too frequently regulated by forces beyond the control of the management, and there is, consequently, in these two factors but limited opportunity for cost reduction. In Expense Cost of product lies the greatest opportunity of effecting economies, and it is this factor of cost which should be thoroughly analyzed, and closely watched so as to keep it down to the lowest possible figure. To do this, the amount of each expenditure going to form the aggregate Expense Cost of product should be known very promptly after the close of each period,—week or month, as the case may be,—and should be subject to constant comparison, not only with similar records of preceding expenditures, but also to items of related interest.

The basis on which manufacturing expenses are distributed on cost of product is a point regarding which, in Canada at least, there is little uniformity of practice amongst foundrymen. Some distribute such expenses according to the weight of output, some on the labor and material cost of product, some on the ratio of Manufacturing Expenses to the value of productive labor, and others again on the ratio of Manufacturing Expenses to the number of productive hours worked, irrespective of the wage price per hour. Competitive bids based on cost records secured by such widely different methods constitute unsatisfactory competition, are demoralizing to the trade interested, and are a strong influence towards creating unsatisfactory and unstable market conditions. This subject might with advantage be discussed, and possibly some uniform practice adopted by those connected with the same line of manufacture, and interested in the same branch of industry.

Uniform accounting methods are perhaps more important than would appear at first sight:—not so much uniofrmity as between different plants,

as uniform methods to be used continuously in each plant. If a foundryman or manufacturer distributes his expenses during five different years according to the five different plans, previously mentioned, the value of his records of costs and results for those years is largely destroyed. This is not intended as an argument that present methods should be continued, simply because "We have always done it that way," it is meant as a plea for a very thorough consideration of the subject, and a determination in view of the conditions of each plant and business of what is the right and logical method of distributing expenses on product, of obtaining costs, and of carrying the results into the books.

DEVELOPMENTS OF THE THERMIT PROCESS IN FOUNDRY PRACTICE.

BY W. M. CARR, NEW YORK CITY.

During the last convention there were presented to your notice a few explanations and experiments outlining the Thermit process. In the interval since that time a diversity of accomplishments have been attained in actual practice, too numerous to discuss exhaustively in the limited space of a single paper. Reviewing the experience, a few of the principal and representative practices will be touched upon.

Most of you no doubt have at least some acquaintance with the reaction of the Thermit compound, which evolves such a convenient, condensed supply of heat in such a simple manner and of pronounced practicability; a high range of temperature not to be had by any other means known to iron foundry practice.

The practical results reached with the assistance of heat produced by Thermit can be mentioned as follows:

In a number of cases where it was important to pour light, thin sections and where the metal was rather dull, the desired increase in temperature and fluidity was gained by an addition of Thermit placed in the bottom of each hand ladle into which the iron was poured from the bull ladle. The Thermit having been primed with the necessary ignition powder, immediately reacted and because of the well known heat, the object sought followed. In this way the castings were free from cold shuts and there was the satisfaction of the foremen in seeing respectable reports with a minimum loss from scrap or defective castings.

Along similar lines in a well known and important steel foundry, recourse was had to the calorific value of Thermit bringing about results that had never been obtained before. The plant was equipped with a single 2-ton Tropenas convertor and only one 5-ton ladle. It was desired to pour some ingots and castings requiring twice the capacity of the convertor. Attempts had been made to make two heats separately and pour them both into one ladle. Much difficulty was encountered by the first heat chilling, while the second heat was being blown to the extent that the ladle was heavily skulled by cold steel, causing much loss and annoyance. The drawbacks to this method of making "double blows" were overcome by keeping the first charge of steel hot and liquid by the insertion of Thermit cartridges attached to iron bars and plunged to the bottom of the ladle at regular intervals during the progress of the second heat, which occupied about 45 minutes. When the second heat was poured into the ladle holding the first one treated as described and after pouring a few castings and finally the ingots, the ladle was found to be entirely free from skull, proving that a good temperature had been preserved by the Thermit heating compound. As mentioned, this result had never been accomplished before in this particular foundry when "double blows" had been attempted.

In the treatment of large headers—both iron and steel—the application

of Thermit in suitably sized cartridges has kept them open longer and produced a better feeding effect than any other known means.

In the manufacture of semi-steel castings, two uses have developed from the agency of Thermit. First, when the necessary steel is melted in the cupola with the regular charge, the insertion of a semi-steel Thermit cartridge in the ladle produces a poling action, which thoroughly mixes the metal with no loss in temperature, because the heat of the burning compound more than offsets any possible chilling effect when poling may be done. Second, if it is desired to make but a few semi-steel castings among a larger number of ordinary castings, steel borings or chips can be put in the ladle bottom, the iron tapped in, and by the insertion of a semi-steel cartridge the steel will be melted and thoroughly and completely dissolved in the iron. This obviates the necessity of making special heats for occasional semi-steel castings.

Concerning repairs to castings in gray iron work, the general practice is to greatly raise the temperature of a quantity of molten iron by an additional of Thermit and applying the iron so regenerated in the usual manner of "burning on." In this way the repair is effected by much less iron than would otherwise be required and there is greater assurance that the weld or fusion of the parts will be better than under ordinary conditions, for the simple reason that the iron used for fusing, and treated, is hotter than it generally leaves the cupola.

Repairs to steel castings in open-hearth plants are obtained by the direct application of the steel produced by the Thermit reaction. Repairs so made, under conditions where due attention has been given to such precautions as cleanness of the parts, a pre-heating of them and dryness of mold, stand inspection when the specifications as to reliability are most rigid. The process is in daily use in all progressive and well ordered steel foundries. In Tropenas plants the practice is to follow the same plan as in grey iron foundries—to pre-heat the steel by Thermit and make the welds by it. This is possible, because they are equipped with small ladles and have the advantage of much hotter steel from the convertor to begin with, than the open-hearth foundries.

An interesting point brought out by the use of the Thermit heating compound, is that it has been found that the effect of the compound upon molten cast iron is to cleanse it, close the grain and materially increase the strength not unlike that produced by titanium Thermit. The action is no doubt due to the heat developed, which must increase the fluidity of mechanically or chemically fixed impurities and bring them to the surface. Not enough is added to sensibly change the usual chemical composition with the mild steel produced by the reaction. The improvement in properties mentioned can then only be reasonably explained by the beneficial action in fusing off possibly dissolved oxides or impurities. It is recognized that there is a need for some agent to bring such removal about, because it is generally agreed that molten pig iron can carry some form of oxides more or less objectionable. Possibly the advent of the Thermit process may offer a solution in that direction, since the results as cited point that way.

These points are only mentioned with the hope of interesting you and to show you that progress is being made hand in hand with the spirit of the times, the lessening of uncertainties, the elimination of losses, improvement in product and peace of mind of the foundryman.

XUM

"GOOD MOLDERS"—WHY ARE THEY SCARCE?

W. S. MCQUILLIN, SOUTH NORWALK, CONN.

Among the many problems with which foundrymen of the present day are confronted, is one which appears to demand the closest attention. This problem is the future supply of competent molders.

It must be plain to all that there is under prevailing conditions much waste of material, time and labor, a better knowledge of which on the part of those by whom they are handled could effect considerable savings.

Nearly three thousand years have passed since the time when Hiram was called to Jerusalem from Tyre to make the great vessels, columns, and certain other parts for the famous temple of King Solomon, descriptions of which lead us to the conviction that they were among the greatest achievements of the molders art, and that Hiram and those employed with him upon the work were mechanics whose skill and knowledge were of a high order.

As our minds turn back over the past and we consider what has been done, it seems only fair to expect that the skill of molder would have kept pace with the many changes and improvements which advancing civilization has brought about; and that the art would be practiced by them upon a much higher plane than it is today. It is the universal opinion among foundrymen that good molders are scarce and that they are growing scarcer year by year, and we hear much complaint that the craft in general is not up to the high standard of competence which should mark the present times. Those who are brought daily in contact with molders could give many instances that would go to show the lack of skill and ability in the average molder. Especially is this true in the jobbing shops where the endless variety in structure and design of the goods they are called upon to produce, calls for "all-around" workmen whose intelligence and judgment should enable them to successfully cope with the many difficulties encountered in the making of castings. The average molder seems to possess very little knowledge of these things, and is almost totally ignorant of the laws governing "cause and effect." We still find him working along with the same old "cut and try" methods, using his mind to little purpose and trusting always to "luck" more than to good management and an exercise of judgment, to produce results.

How often we marvel at the reasons advanced by molders to account for their failure to obtain satisfactory results. If a small part of the ingenuity displayed in forming excuses was employed to invent ways and means of preventing losses or poor work, the average of "good luck" would be higher than it generally is, or if their excuses were always thought out before a job was commenced they would seldom be required to offer them when it is completed.

Too often in the foundry, more importance is attached to "luck" than good management and a fair knowledge of the results that should naturally follow certain practices. There is abundant proof of the existence of these conditions in the business, and though there are molders whose abilities should entitle them to rank among the best mechanics (even artists) there is reason in the belief that a large proportion of the craft are deficient in many of the qualities that would entitle them to such rank, and it would not be a stretch of truth to say that they are not mechanics in any sense of the word, much less artists. Still many of this latter class are traveling about bearing the stamp of first-class workmen, which implies that they should be entitled to all consideration as such. But their ability and true value can be discovered only after time and materials have been wasted by them in practice upon work that

should present no problems that they could not have mastered in the first years of their apprentice-ship, if they had trained their minds to work out these problems.

Now if these complaints are justified there are reasons, and it appears to be the duty of all who have the future welfare of the foundry business at heart to inquire into the causes responsible for these conditions, and in line with the educational, and advancing principles proclaimed by this association, do what may lay in their power to remedy the difficulty.

Are there reasons connected with the business that the foundry attracts only human material that is not fitted for other vocations, where the exercise of brains and a certain standard of pride in work, is required? Are there so many more inviting positions open to young men of ambition and intelligence that the foundry can secure none but those whose only qualifications seem to be ability to stand hard work under the many disagreeable conditions to be experienced in the dirt and smoke incident to foundry procedure? This while on all other sides appear the evidence of light, clean and pleasant employment with opportunities of advancement or at least an occupation at which they will be able to earn a living in their older years.

Is there nothing to show that this industry is one that demands abundant talent, and that in spite of the features that appear disagreeable, its followers have many opportunities of advancing far above the level of common labor. Does the appearance of the conditions mentioned keep away the good stock of which mechanics are made, or does the actual existence of these conditions in the foundry blunt and destroy all desire for knowledge and advancement with which the average human being is endowed?

Is the modern foundry practice of specializing, and the introduction of the molding machine, a cause of the wanting competence of the molder as a mechanic? Does the practice along these lines keep a man down to the level of the common laborer of whom no more is required than a certain set of motions in which the mind takes very little part? Is this the class of molders that the business is producing, generally? The foundryman of the present day is confronted not with a scarcity of molders well developed, strong, able, and willing to work, but with a scarcity of molders well developed mentally, able, and willing to think.

It seems proper that we should here ask, to what extent foundrymen themselves are responsible for the scarcity of good molders. Are the conditions imposed upon men working at the trade such that they have no chance to develop their minds as well as their muscles, both of which are so important to the production of a paying quantity of good castings? Is the ever straining and crowding to produce a quantity, that will enable foundrymen to compete with each other for a low price, one of the factors which tend to get a molder into the habit of disregarding the many things so important for the production of quality? Is competition (which we are told is the life of trade), the desire and determination to produce more castings for less money than some other foundry, a cause that contributes to this scarcity of good molders?

It is to be feared that there are many foundries in which the facilities and equipment is by no means up to date, and still molders are expected to produce castings in competition with others in which modern improvements and up to date methods have been acquired.

What premium is usually paid talent and intelligence when it is met with in the foundry? Is it always appreciated and encouraged? Are the bright and faithful men and boys always given opportunity to exercise the talents they may possess? Are they not often kept within such narrow limits for the

sake of convenience and profit that there is small chance for them to expand to the proportion that would fill the void of which we complain? Has the foundry business been made so unprofitable by the low prices, and degenerated to such a condition that only an inferior quality and a superior quantity (which usually go together) can be made to pay?

Much has been written and told relating to irons, fuels, cupola practice, and cost keeping and to show by a more or less thorough analysis of these subjects, how and when the best results may be obtained.

So well have these matters been discussed that in many foundries, that the importance of the melter has far over-shadowed that of the molder. It is true we often read the details of the molding and casting of some important piece of work. A great deal is told of how the different parts are made and handled, but as a rule we are shown only the physical operations of the work, while we are often left to guess the reasons why certain methods are employed. Indeed frequently less notice is given the molder who does the work, than is paid to the ladle or crane by which it is poured.

Now while not belittling the abilities of the men in charge, the credit and glory of the achievement usually goes to them, and little tribute is paid the molder for the part that he has taken in successfully managing the many details of the work. It does seem that a little share of this glory should be accorded him for his part, even as a matter of policy, as it is a law of human nature that man will strive for greater achievements for the sake of fame than he will for pay, and full appreciation seems really a small price to pay for honest effort.

Regarding competition: The foundry is fast undergoing a revolution in which many methods of a few years ago are being abandoned, and much of the work that has been done by bodily labor more or less strenuous, is now being taken care of by machinery. In the future the up to date foundry will not experience so much trouble from the scarcity of good molders, as the most intelligent will be attracted to them. They will there find many opportunities for using their brains, while steam air and electricity will do the rest. The foundries that have not kept pace with the times will get only those of little use to anybody and will be obliged to work them harder to make a showing in the competition with their more advanced and up to date rivals.

Man is by nature a thinking animal and those who possess considerable intellect, are not looking for jobs in which ability to perform physical labor is the principal requirement.

Recognizing these facts, it must be plain that the successful foundries of the future will be those in which the greatest amount of hard labor and disagreeable conditions have been eliminated; and those who choose or feel compelled to remain in the old rut, will always experience the scarcity of good molders, or if they do secure them will pay a high price for their product.

In connection with these subjects, the sanitary condition of the foundry should not be overlooked as having its influence upon the help. For "Cleanliness is next to Godliness." It does not seem necessary to enlarge upon this, as we all recognize the elevating influence of clean and healthful surroundings.

Before closing, it might be interesting to note that the establishment of trades schools for learning the art of molding have been more or less widely advocated, in which young men of promise might be taught the rudiments of the business, while earning a living and keeping the institution upon a paying basis. In the absence of the resources necessary for the establishment of such institutions, would it not be wise to make some practical application of the suggestion to the foun-

XUM

dries that are already in operation? It certainly seems that some more effective and advanced methods of educating molders than those now in vogue must become a part of the foundry business in the future, if there is to be a higher standard of efficiency in the trade.

The time is not far distant when a vast deal of the work now requiring more or less skilled molders, will become specialized and handled in greater volume by special methods and machines, requiring little skill to operate. In spite of this, however, there is, even in the dim future, no indication that thoroughly trained, and educated mechanics will not be needed. On the contrary while mother earth continues to give up the bountiful supply of metals used in casting, there will be a demand for "good molders."

METALLURGICAL SECTION OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION.

H. E. DILLER, SECRETARY.

REPORT OF THE COMMITTEE ON STANDARD METHODS FOR THE ANALYSIS OF IRON.

In our last annual report a standard method for the determination of silicon in iron was outlined, and at the session of the Metallurgical Section this method was adopted as the official standard. Printed copies of the method were sent to several hundred foundry and blast furnace metallurgists and chemists and brought forth such favorable comments that your committee was encouraged to go further with the work this year, and now submits for your criticism methods for the determination of Total Carbon and Sulphur.

Total Carbon.

This determination requires considerable apparatus; so in view of putting as many obstacles out of the way of its general adoption in cases of dispute your committee has left optional several points which were felt to bring no chance of error into the method.

The train shall consist of a pre-heating furnace, containing copper oxide (Option No. 1) followed by caustic potash (1.20 S. Gr.), then calcium chloride, following which shall be the combustion furnace in which either a porcelain or platinum tube may be used (Option No. 2). The tube shall contain four or five inches of copper oxide between plugs of platinum gauze, the plug to the rear of the tube to be at about the point where the tube extends from the furnace. A roll of silver foil about two inches long shall be placed in the tube after the last plug of platinum gauze. The train after the combustion tube shall be anhydrous cupric sulphate, anhydrous cuprous chloride, calcium chloride, and the absorption bulb of potassium hydrate (Sp. Gr. 1.27) with prolong filled with calcium chloride (Option No. 3.). A calcium chloride tube attached to the aspirator bottle shall be connected to the prolong.

In this method a single potash bulb shall be used. A second bulb as sometimes used for a counterpoise being more liable to introduce error than correct any error in weight of the bulb in use, due to change of temperature or moisture in the atmosphere.

The operation shall be as follows: To one gram of well mixed drillings add 100 c. c. of potassium copper chloride solution and 7.5 c. c. of hydrochloric acid (conc). As soon as dissolved as shown by the disappearance of all copper, filter on previously washed and ignited asbestos. Wash thoroughly the beaker in which the solution was made with 20 c. c. of dilute hydrochloric acid (1-1), pour this on the filter and wash the carbon out of the beaker by means of a wash bottle containing dilute hydrochloric acid (1-1) and then wash with warm water until all the acid is washed out of the filter. Dry the carbon at a temperature between 95 and 100 degrees C.

Before using the apparatus a blank

shall be run and if the bulb does not gain in weight more than 0.5 milligram, put the dried filler into the ignition tube and heat the pre-heating furnace and the part of the combustion furnace containing the copper oxide. After this is heated start the aspiration of oxygen or air at the rate of three bubbles per second, to show in the potash bulb. Continue slowly heating the combustion tube by turning on two burners at a time, and continue the combustion for thirty minutes if air is used; twenty minutes if oxygen is used. (The Shimer crucible is to be heated with a blast lamp for the same length of time.)

When the ignition is finished turn off the gas supply gradually so as to allow the combustion tube to cool off slowly and then shut off the oxygen supply and aspirate with air for ten minutes. Detach the potash bulb and prolong, close the ends with rubber caps and allow it to stand for five minutes, then weigh. The increase in weight multiplied by 0.27273 equals the percentage of carbon.

The potassium copper chloride shall be made by dissolving one pound of the salt in one liter of water and filtering through an asbestos filter.

Option No. 1. While a pre-heater is greatly to be desired, as only a small percentage of laboratories at present use them, it was decided not to make the use of one essential to this method; subtraction of the weight of the blank to a great extent eliminating any error which might arise from not using a pre-heater.

Option No. 2. The Shimer and similar crucibles are largely used as combustion furnaces and for this reason it was decided to make optional the use of either the tube furnace or one of the standard crucibles. In case the crucible is used it shall be followed by a copper tube 3-16 inch inside diameter and ten inches long, with its ends cooled by water jackets. In the center of the tube shall be placed a disk of platinum gauze, and for three or four inches on the side towards the crucible shall be silver foil and for the same distance on the other side shall be copper oxide. The ends shall be plugged with glass wool, and the tube heated with a fish tail burner before the aspiration of air is started.

Option No. 3. Barium hydrate is so extensively used as an absorbent for the carbon dioxide that your committee decided to make no recommendation as to whether its use should be made optional, but leave that point to be decided at the general meeting of the Metallurgical Section.

Determination of Sulphur.

Dissolve slowly a three gram sample of drillings in concentrated nitric acid in a platinum dish covered with an inverted watch glass. After the iron is completely dissolved add two grams of potassium nitrate, evaporate to dryness and ignite over an alcohol lamp at red heat. Add fifty c. c. of a one per cent solution of sodium carbonate, boil for a few minutes, filter using a little paper pulp in the filter if desired, and wash with hot one per cent sodium carbonate solution. Acidify the filtrate with hydrochloric acid, evaporate to dryness, take up with fifty c. c. of water and two c. c. of concentrated hydrochloric acid, filter, wash and after diluting the filtrate to about 100 c. c. precipitate with barium chloride; filter, wash well with hot water, ignite and weigh as barium sulphate, which contains 13.733 per cent of sulphur.

REPORT OF COMMITTEE ON STANDARD METHODS OF MAKING BEDS.

Your committee in undertaking this work, was fully aware of the difficulties to be met with in having molders who are accumstomed to their own ways follow any rule, or set of rules, laid down for them. For that reason we gave the table prepared by Mr. West to an apprentice, who had been working at the trade about a year and

instructed him to follow the directions to the letter.

It must be said that this apprentice turned out exceptionally good work as the result, for his plates when cast far surpassed those made by molders of mature years and experience. As the apprentice progressed with the work he became more and more interested, and a decided improvement manifested itself in casting after casting, as it was made. The metal was poured in various ways, and but two plates were scarred and then only ⅛ inch deep.

For plates with wide and deep prickers, we took the additional precaution of driving down cast iron rods between the rows of prickers and thoroughly venting them with a 3-16-inch vent wire. After building the runners and cleaning out the loose sand from the surface of the plate, we took a dust bag and shook on a fair coating of Portland cement, which has a tendency to form better surfaces than plumbago or lime. As the cement, after standing a few minutes, absorbs moisture from the sand and sets, it leaves a very tough and rigid surface, without being hard. This reduces the possibility of cutting in front of the runners, and holds the edges around the prickers in a very firm manner.

We present this report for your information and approval, and suggest that all foundrymen who are doing this class of work, and wish to save money, should adopt Mr. West's method. We feel certain that once it becomes better known, foundrymen will appreciate what Mr. West has done for them in this particular.

We would respectfully submit, that our work being accomplished, that the committee be discharged. We further advise that the foundrymen of this country take up the question for themselves and communicate their results to the secretary of the association, so that the next meeting may thoroughly ventilate it, and added information be thus obtained.

Respectfully submitted for the committee,

CHAS. H. THOMAS, chairman.
South Norwalk, Conn., May 18, 1906.

THE ELECTRIC CRANE IN THE FOUNDRY.

BY HARRY SAWYER, MUSKEGON, MICH.

It is not the purpose of this paper to enter into a technical discussion of the electric cranes, but such a presentation of the subject as will lead to a better understanding between makers and users cannot fail to be mutually profitable.

The use of the electric crane in the foundry doing heavy work has become so general that even a reference to the older methods, by way of comparison, seems uncalled for.

It may be interesting, as a bit of history, to note that the first three-motor electric traveling crane built in the United States, and probably in the world, was for use in a foundry. It was put in operation only a little over seventeen years ago. Although it was constructed from the wreck of an old rope-driven crane, it did good service night and day for nearly ten years. It was the invention of Alton J. Shaw, then employed by the E. P. Allis Co. as a designer, and was used in the foundry of their Reliance works, at Milwaukee.

There have been some interesting phases in the development and introduction of the electric crane. The skepticism of those in need of such machines, and the opposition of those engaged in the manufacture of the earlier types, was to be expected; but it is only fair to say that the users of cranes were quicker to recognize the advantages of the new type and to adopt it, than were the makers of the old.

The use of the electric motor and the sliding contacts, solved in so satisfactory a way the problem of transmitting power to a moving machine, that the traveling crane rapidly super-

seded the swinging crane in nearly all classes of foundry work where a crane is required. In one notable instance,—pipe foundry work—the swinging crane was retained. Whether this was due to some peculiarity of the work that made the circular pit and the circular movement essentially better than the rectangular pit and corresponding crane movements, or whether it was due to the natural persistency of established practices, seemed for a time to be an open question; but the recent equipment of several pipe foundries with traveling cranes, indicates that the latter was the correct explanation.

It is no doubt true that the foundry has set the standard of excellence for electric cranes. Some shops and mills may have heavier loads to handle and require greater speed, but the crane manufacturer recognizes that the perfect control required in the foundry, represents a higher state of development than mere requirements of capacity and speed. It should not be understood that good control is not required in mills and shops, particularly the latter, but as a rule the requirements of the foundry are much more exacting.

The conditions under which a foundry crane is operated, are less favorable to continued good service than the conditions in a machine shop. It is more subject to overload, and the dirt and dust necessitate more careful attention; furthermore, the men directly responsible are usually less familiar with machinery, with the result that the crane too often does not have the care that it should. It is a mistake to assume that a crane which does the work of an army of laborers, can safely be handled and cared for by one of that class. The importance of employing only thoroughly competent and conscientious operators, and keeping the cranes in perfect repair cannot be too strongly urged. Prompt attention will reduce the total cost of repairs and the extra cost of careful and competent men, will be saved many times in the more constant service and longer life of the crane.

There is at the present time something of a demand for excessively high speeds, and the motives of the manufacturers who advise against them, are sometimes misunderstood. It is not that the problem presents any difficulties from the manufacturer's standpoint. He may prefer to furnish a standard article, from considerations of cost and delivery, but oftener he is considering the direct benefit to the customer and the indirect benefit to himself. The manufacturer and user may recognize the same advantages, and disadvantages but from their different standpoint, they do not see them in the same proportion.

The one advantage sought in high speeds is a saving of time, but this is often overestimated. Take for example a 10-ton crane with full load speed of 20 feet per minute. We may assume that the average load will not be more than one or two tons, that the average speed for such load will be 30 feet per minute, and that the average lift is five feet. Allowing 50 per cent more time for acceleration from a state of rest, and we find the time for an average lift to be 15 seconds.

If the speed of hoist were doubled, it would at first appear that one-half of this time, or 7½ seconds, would be saved. If 20 lifts were made per hour, the result would be a saving of only about four per cent of the time. When it is remembered that many of the lifts must be very slow, regardless of what the crane is capable of doing, and that traverse movements are usually started as soon as the load is clear of surrounding objects and before the hoist movement is stopped, the actual saving is reduced to a very inconsiderable amount of time.

Where a large floor area is covered, a greater saving can be made by increasing speeds of horizontal movements, but the swaying of load which results from high speeds and sudden

starting and stopping, sets a limit to the saving that can be made in this direction.

Two objections may be offered to excessively high speeds. First, the accidents that are likely to result from putting a high speed crane in the hands of an incompetent operator often cause the loss of much more time than is saved by the higher speeds, and greatly increase the cost of repairs. Second, if the crane is not usually run at full speed, there is a constant loss of power in the rheostat, and unnecessary wear and tear on the controller parts, both of which cause expense and loss of time. The above comparisons apply with the most force to cranes in foundries, and with least force to cranes in mills where much higher speeds are necessary and practical.

Next to the requirement of necessary strength in all parts for absolute safety, the most important point to be considered is perfect control of the hoisting mechanism. This depends upon three parts; the motor brake, the load brake, and the controller.

The motor brake is released by the current which operates the motor, and should require only as much current as is necessary to drive the machinery without load. It should be sufficiently powerful to bring the armature to a stop promptly, but without shock, when the current is interrupted.

The load brake is a far more important part. It must allow the machinery to run freely in hoisting, but prevent the load from descending, except when the motor is run in the lowering direction. In most, if not all forms of load brakes now in use, the brake is applied by the action of the load. They may be divided into two classes: one in which the brake pressure is not reduced in lowering, but the motor acts with the load to cause the brake to slip; and the other in which torsion of the motor in the lowering direction reduces the pressure between the surfaces, allowing the brake to slip and the load to descend. The most common of the first class is the enlarged step bearing on a worm shaft. It can be used only in connection with worm gearing. It is a very simple and may be made a very satisfactory working brake. The most serious objection to it is this: If proportioned to give a fair margin of safety with the best conditions of lubrication, it will take considerable power to lower with moderate or poor lubrication, for the motor must overcome any excess of holding power over that necessary to sustain the load. This extra work in lowering means loss of time and power, and greater wear of parts.

Of the second class, there are two types: the coil type and the disc type. Both have their advantages and disadvantages. The disc type is more substantial in construction, gives better distribution of pressure over the friction surfaces, and consequently a much lower unit pressure; and as the pressure is strictly in proportion to the load, it gives higher speeds in lowering light loads. It has this disadvantage, that it is more sensitive to irregularities in lubrication.

In the coil brake the pressure and wear are concentrated principally at one end. While the brake is applied by the action of the load, the pressure and resistance to slipping are not strictly in proportion to the load. The torsional effort of the motor to release the brake is dependent upon the proportions of the brake parts, and not upon the load, hence the speed in lowering is approximately the same for all loads.

Both types are used by reputable builders, and both may be designed to give good results.

A good controller is indispensable to a satisfactory crane. The essential parts of the controller are the resistances and the means for varying the amount of resistance in the circuit, according to the speed and power required. The most common practice

is to divide the resistance into sections, connect the sections together in series and connect each section to one of a series of corresponding contacts. A brush is arranged to pass over those contacts, cutting more or less of the resistance into or out of the circuit. Various materials may be employed and details used to obtain the desired result, but certain conditions must be complied with if satisfactory results are to be secured.

The total resistance may be sufficient to allow the passage of only enough current to start the motor at a very slow speed with its smallest load. The number of sections must be sufficiently great and the resistance of these sections sufficiently small that no sudden or abrupt changes of speed will occur from the time the first contact is closed, sending the current through the resistance, to the time that all the resistance is cut out, and the motor is given full current.

Durability of the controller and convenience in making repairs, are important considerations. The construction should be such that neither the resistance material or the supporting insulation will be injured by the heat. Conservative rating and good ventilation are required to keep the temperature down to a safe point. Sparking and burning of contacts cannot be entirely prevented, but proper proportion of resistance to avoid great changes in voltage between consecutive steps, and a well designed magnetic blowout will prevent serious burning. The brushes and contact pieces must be renewed occassionally, and they should be very accessible. It is important also that the resistance material should be removable without moving the controllers from their positions in the operator's cage. Economy of space, so far as it is consistent with proper sizes of parts, good ventilation, good insulation and accessibility is of importance.

Crane motors are usually series wound. It seems almost unnecessary to say that they should be very simple and strong mechanically, that the electrical insulation should be of the best quality and that they should be designed to stand great variations in speed and load, and sudden reversals under load without injurious effects. The highest possible efficiency at some one speed and load is not so important as a good average efficiency over a wide range. Motors of low or moderate speeds are preferable on account of the reduced gear ratio required between motor and winding drum or driving wheels.

Referring in a more general way to the design of cranes and the problems and limitations met by the designer, it is the exception rather than the rule, that he has free hands to do as he might wish. Limited space; close approach of hook to roof, sides, and ends of building; perfect accessibility of all parts; a large factor of safety; low price,—these are some of the requirements which, desirable as they may be, are not always compatible.

Manufacturers and users have underestimated the advantages to both of getting together. The manufacturer should understand fully the requirements of the user, and the user should know the full effect of the limitations he places upon the manufacturer.

CORE BINDERS.

BY A. M. LOUDON, ELMIRA, N. Y.

It is with some reluctance that I make the attempt to bring before the foundrymen of the country the problem of core binders, and which will serve the purpose of producing the best core for the work in hand.

Before proceeding further I will take this opportunity to thank each and every one of the core binder supply houses who so generously contributed for these tests the material necessary. Indeed it was the tone of each, in reply to my request to forward samples of their material, "that it was an opportunity they had long sought for."

While the subject affords a good avenue for criticism, I know when I am through that while you may differ with me in some respects, you will feel that you have been given an honest recital of my observations, and that I am not attempting to favor any particular core binder. If you accept this paper in such a spirit I will feel amply repaid for my efforts and expense.

DRY BINDERS.

Test No. 1. Flour sand core mixture, made with new moulding sand two parts, new fire sand one part and from one to twelve to one to eighteen of flour to mixed sand, and wet down with good thick clay wash. Cores made from this mixture are usually very strong, but if not thoroughly dried through and slightly burnt or scorched on the surface, will give all kinds of trouble for the foundryman using this mixture. When not sufficiently dried they will cause blown castings, scabbed castings on core surface, and even causing the mold surface to scab from boiling in pouring, lastly, when castings arrive in cleaning department they cause a heavy expense in extracting the cores. Old marsh or heap sand mixed into this core sand will help, but when old sand is taken more flour has to be used which causes another serious trouble through so much smoke in the shop that men cannot work to advantage. Furthermore cores from this binder give great trouble through the readiness to draw dampness in the mold, causing blowing, especially with small cores in light castings.

Test No. 2. Syracuse dry core compound; this is an entirely modern binder and not as universally known as flour. The first test I made of this binder was one-third old floor sand, one-third new molding sand, one-third sharp or beach sand, mixed well and measured out, adding one part binder to thirty-five parts sand and thoroughly tempered with water. Cores made from this mixture made a quick drying, were clean, sharp and left good surfaces when castings are taken to cleaning department. It was really a boon to the cleaner as he could do so much more work with so much less labor. This mixture withstood the drawing of dampness from the mold very well. (The crucial test given to each mixture was to take a core and dip it partly into a pail of water and allow it to stand for two days and air dry only, all cores being placed on the same shelf and iron cast around the end dipped into the water.) The above mixture was subject to this test with all the others, dry binders, and oil binders alike, and proved entirely satisfactory as the iron lay to the core without a kick or a blow. This binder, in my judgment, is best suited to large plain work or small plain round and square cores.

I also tried a mixture with this binder of one-half new molding sand, one-half sharp or beach sand to 40 parts sand to one part binder, but would recommend the first formula for regular foundry practice.

Test No. 3. A binder was selected which to my knowledge is less known to the trade than any other used today. The test I made with this was one-half old floor sand, one-quarter new molding sand and one-quarter beach or sharp sand first mixed together well, measured out and mixed one hundred fifty (150) parts sand to one part binder. Cores made from this binder mixed as above with sand tempered with water proved valuable for large cores; were strong, sharp-edged, easy dried; in fact, in the case of large cores do not need to be thoroughly dried more than just enough to handle and stand of their own weight on chaplets. This was all that was necessary to procure the very best results; less cinders are used saving the usual mess made in cleaning large castings, as where they can fall out you will usually find them in the pit where cast. The sand usually acts like a green sand core and there are no bad results from mixing in with the heap sand. If the cores from this mixture should be burnt in the oven before removing them from the plates, take some of the binder and dissolve with hot water and wash over

the cores, running cores into the oven for five or ten minutes to heat again. When taken out all the burnt results disappear and cores are in good condition.

For small and intricate cores take one-third old sand, one-third new molding sand and one-third beach or sharp sand, mixed thoroughly and mixed with one hundred (100) parts sand to one part binder; using the usual method to make small cores. This will be found to give excellent results.

A core from this mixture was treated with a bath in the pail of water and allowed to stand for two days, as before mentioned; when the iron was run around this core it acted better than many a mixture just taken from the oven.

These tests were cast in an open mold so that the results could be observed with the eye. This binder has no house controlling its sale. Any one can use it. The name of this friend is dextrine or British gum. Very little gas is emitted from the mold, which is really a very valuable consideration.

Test No. 4. Wago core compound. This first test I made of this binder was one-third old sand. One-third new molding sand and one-third sharp sand thoroughly mixed and added one part Wago to thirty parts sand. This proved to be a core of reliable quality with very little smoke. One very noticeable feature of this mixture was observed. In making a number of cores from a wooden core box, the box did not gum up and make ragged cores, which is usually the case if the box is not cleaned after every core made. Hence a great saving in time in making a large number of small cores.

I next mixed one-half new molding sand and one-half sharp sand with one part Wago to thirty-five (35) parts sand and this made an exceptionally strong core, true and sharp, but was harder to clean out of the castings than the first mixture of Wago.

I tried one of these cores dipped into the pail of water and left for two days to air dry and it lay to the iron just as quiet as the core just from the oven. As stated before, this test was made principally to bring out the feature of cores absorbing dampness from the mold. This material is really a commendable article.

Test No. 5. In this test Cleveland core compound was used. One-third old sand, one-third sharp sand and one-third new molding sand thoroughly mixed and to this added one part Cleveland core compound to thirty (30) parts sand. This was mixed and tempered with water. The core made from this mixture proved very satisfactory for general cores. It makes a good strong core easily cleaned from the casting after it became cold. As the cores proved strong, I tried a mixture of one to forty but found for actual practice that one to thirty is best suited for this binder, as the cores made from one to forty were decidedly soft after being dried. The cores from one to thirty mixture were subjected to the water pail test and acted very much like on oil core, the core being air-dried for two days it was cast around and gave excellent results.

Test No. 6. In this test I used Peerless core compound. One-third old sand, one-third sharp sand and one-third new molding sand thoroughly mixed and as I made all previous tests with the exception of flour and dextrine with thirty to one, I used thirty parts sand to one part peerless core compound, but found that this would not stand the test, so I mixed another batch one peerless to twenty sand and this mixture proved very satisfactory, being strong and true to the box after being dried. It was a little harder to clean out of the casting than most of the others up to this point, but I attributed this cause to the greater quantity of compound used to hold the sand together. This core also was tested with the bath in the water pail and proved very satisfactory, being air dried for two days and iron cast around it. The iron showed no signs of blowing.

Tests Nos. 7, 8 and 9. These tests were No. 1, No. 2 and No. 3 flours sent me. I mixed the sand same as all other mixtures but used No. 1 flour one to

fifteen, No. 2 flour one to eighteen, and No. 3 flour one to twenty. I ran these tests for comparative results of the flours; I found that No. 1 made the strongest core, but hardest to clean out of the casting; No. 2 was very good for general work; No. 3 was too soft, so I tried No. 3 flour one to eighteen and found this to be about right, as this core was even better than No. 2 at one to eighteen. I subjected each of these cores to the bath in the water pail, but each core took up the water like a sponge, for when the cores were withdrawn from the water the core showed the water entirely absorbed and by holding the cores flat they broke off at the line where the water reached. No. 2 and No. 3 showed even worse than No. 1, which I expected to act like a common flour sand core.

The core from the peerless compound, and most of the others, showed the water on skin of core just the same as water on an iron pipe and could be wiped off with a rag without injuring the core.

Test No. 10. Paxson dry core compound. This material is well known to the trade. I took this and put it through the same test as the others, mixed one-third sharp sand, one-third new molding sand and one-third old sand, then added one part Paxson dry compound to thirty parts sand; this proved a very soft core, in fact I made two very large cores and one of them had to be thrown away, it proved so weak, being a little burnt. I then tried one to twenty and this made a very strong core. I took one of these cores and subjected it to the water bath, and this core broke all up in it. There seems to be conclusive proof that while this mixture made a very strong core when baked, that it must be watched very carefully when placed in the mold for some time before casting. A mixture of one-half sharp sand and one-half new molding sand and one to twenty made a strong open core, but the moisture easily affected it as in the other mixture with the same core compound. This concludes the dry core compounds.

LIQUID CORE BINDERS.

Test No. 11. Holland linseed oil. One part oil to thirty parts sharp sand makes a strong rugged core of almost any shape in the small and medium cores, but would advise foundrymen who would rather be sure than sorry, to make no cores from this oil without vents. I believe that all oil cores made successfully depend upon the method of drying as much as on the quality of the oil.

It may be the experience of many foundrymen that some days better results are obtained than on others with the proportions of oil and sand constant. If anyone would adopt a system of standard temperatures as found by practical tests with their own ovens, using thermometers and then baking for a specified time, nearly constant results would be obtained. Still even with this precaution the results may be off the mark at times. To make first-class oil cores is a science, as those producing intricate cores know.

The cores obtained from the above test were tried with and without vents in almost every possible position to make difficult propositions for a foundryman and the cores with the vents stood out so pronounced over the no-vent cores that I must say the extra trouble is well paid for. A core left in a pail of water one-half hour was returned to the oven and dried and seemed to be as good as the others which had never seen the water.

Test No. 12. Syracuse core oil. I mixed a batch of sharp sand thirty-five parts, oil one part, tempered with water and mixed well; this mixture made really excellent cores. They were ordinary square and round cores and small steam water jacket cylinder cores, port cores, etc. The results obtained were highly commendable to the trade generally. Vents were used in all the practical tests applied, while cores with no vents were tried in various shapes and positions, but were not satisfactory as the iron was run around the cores in open molds to watch the results. A core from this mixture was put in a pail of water for 15 hours, taken out and dried in oven

for fifteen minutes. Iron cast around it and proved excellent.

Tests Nos. 13, 14, 15. Sterling oil. Three samples were sent by this house, No. 1, No. 2 and No. 3 samples. I mixed these three samples of oil at one time, placing them beside each other; they were mixed one oil to thirty-five sharp sand. No. 3 oil was about right; No. 1 and No. 2 were mixed too much oil, which made them hard to bake; I then increased the sand one part oil to forty-five parts sand, this mixture dried out better and made good strong cores from No. 1 and No. 2, but when subjected to water the moisture acted quickly on them, much more rapidly than on the other oil sand mixtures.

For strong cores to be used up as made, this oil gave nicer acting cores on the castings and easily cleaned out, but I left two different kinds of cores in molds over night, having cast duplicates previously from the same batch with excellent results, the two molds left over were cast the following day, and blew terrible for an oil core. I tried several samples and cores subject to dampness, but they will blow without a let-up until the iron sets.

Test No. 16. Gluetrin or Esso core binder. This was mixed one-third new molding sand, one-third sharp sand and one-third old sand mixed well, then one part gluetrin to thirty parts sand was mixed, so that the same proportion was used as the other mixtures. The cores from this mixture were so hard that the iron would not lay to them. I then mixed a batch with the sand the same proportion as before, only used one part gluetrin to fifty parts sand and these cores were good sharp and strong cores, cast much better, but still were affected by blowing a little. I would here state that I mixed the gluetrin with water as directed and then tempered the sand with water. Having succeeded in improving the results by increasing the quantity of sand, I took another batch of the sand and mixed one part gluetrin to seventy parts sand; these cores were very decidedly soft when compared with the other mixtures and did not stand the fire so well. I subjected one core from each sample in the water bath, same as the other mixtures; one to thirty was very good; it did not soften very much, but had to be dried again; one to fifty took up the water very easily and became very soft; one to seventy acted like a stick of sugar, melted away in the water and showed that a core of the proper quantity for a free core not inclined to blow, that it took up the moisture very quickly. A core saturated with gluetrin did not take up the moisture as readily, but was too susceptible to blowing. Cores from all these mixtures were surrounded in open molds with iron as the others were treated, and the above is a concise report of the results.

Test No. 16. Glue melted in hot water. Mix one-quarter new molding sand, one-quarter sharp sand and one-half old sand; one pound glue, melted, to each one hundred pounds sand for small cores. One pound glue, melted, to one hundred fifty pounds sand for all large and medium cores. Use either lump glue or granulated, the poorer and cheaper the quality you can buy you will find to give the best results.

I daily make small cylinder port cores from the first formula without vents and obtained excellent results, in fact, cores of every description can be safely made with the best results, the only point to be observed closely is that the cores are properly dried. Cores for large beds have been made in the mold three and four days before casting and never caused any trouble.

Cores from this mixture, subjected to the water test, showed a tendency to absorb moisture, but would stand up to their shape when withdrawn from the water and after re-drying showed as good as new made cores. If cores made from this mixture should be burnt, mix lead wash, using glue for liquid, washing the cores over, re-drying them they are as good as new.

Test No. 17. Glucose melted with hot water, using the same sand as most of the other tests, one-third sharp, one-

XUM

third new molding, and one-third old sand. Cores made from this material, one pound to one hundred pounds sand, make first class cores of every description, being very easily dried, easy to clean out of casting, in fact, the cores act like a green sand core dried, while the natural vent would come off. No smoke was observable when cast. In every respect this material showed excellent results.

As I have exhausted all the materials at my command in this series of tests, I submit the results found for your consideration and guidance, if possible, and hope that this paper may be the means of other foundry owners and foremen making the same or similar tests for their own or others' benefit.

PATTERN SHOP EQUIPMENT.

The most advantageous arrangement that can be given a pattern shop depends wholly upon the floor plan, the number of men employed, and the character of the work. The character of the work in turn determines in a large measure the size of the pattern shop, the equipment required, and the location of the shop. When possible, the pattern shop should be placed on the ground floor, and this is particularly true where large face plate lathes are employed, as their foundations cannot be made too rigid.

The inconvenience attending the getting of large patterns up and down the stairway, or on and off an elevator, as the case may be, is another good reason why the ground floor is a better location for this department.

The handling of the lumber into the shop can also be accomplished with very much greater ease if the ground floor is selected.

Power Transmission.

The ideal arrangement for power transmission is, of course, electrical driving with a motor for each machine. Band saws are now made with a motor directly connected to the shaft of the lower wheel, while all the other machines can be driven by a motor mounted upon the machine bed, or upon the floor adjoining it. These motor drives take up but a small amount of space, and do away in part with the nuisance of belts. In the case of a jobbing pattern shop an important consideration is that the power is usually rented, and when electrical driving is employed only the machines in actual use need be run, which will result in a very marked saving in the total year's expenditure for power. When this system is not installed and line shaft is used, it should be placed below the floor, in order to facilitate its control and avoid the loss of floor space taken up by countershafts, shifters, etc. When the line shaft is arranged in this manner it will necessitate a shallow basement underneath the pattern shop. Machines requiring heavy foundations can be placed on concrete piers extending through the basement.

Pattern Shop Arrangement.

The ceiling of the shop should be high and well supported, preferably by carrying it with truss rods from the roof, as this will avoid columns or other supports which are in the way of laying out or constructing large work. Plenty of heat and light are two very essential features in the pattern shop, and should always be kept in the foreground when laying out this department. The lavatory and cloak room are also important. The cloak room should be fitted with individual lockers for the workmen's garments, and should be in charge of the sweeper or some other party who will see that it is kept locked during working hours and also that it is kept clean and well ventilated. It is a serious mistake to place the cloak room in some dark, out-of-the-way hole. It should be so located that it is light and airy in order that it may be kept clean and sweet.

The foreman's office should receive attention early in the lay out. If the shop is long, the office should be located along one wall near the center of the shop, the office floor being raised about four feet above the general shop floor, and the walls constructed of glass. There are two advantages in this arrangement; first, it gives the foreman command of

the entire floor so that he can see what is going on at all times. Second, it places the office in the warm air stratum of the room. A man at work can keep warm in a temperature of from 67 to 68 degrees Fahr., which is about right for the ordinary pattern shop, but a man sitting at a desk usually wants a slightly higher temperature.

One important department which often receives scant attention is the finishing department. To do good varnishing the temperature should be kept above that of the ordinary working rooms, and the air should be free from dust. To accomplish this it is necessary to partition off a separate space and set it aside for checking up and finishing patterns. This work should, wherever possible, be conducted by men assigned especially to this class of work and not by the regular patternmakers. Where two radically different classes of patternmakers are carried on, as for instance, wood and metal or heavy and light, two separate pattern rooms are sometimes used with the foreman's office and finishing room located between them. The stock room can also be located between the pattern shops. The stores or supplies should be in charge of one man, who should issue them and see that they are charged to the proper jobs.

When the material or lumber is gotten out by each individual workman, which is the customary practice in most shops, and especially when the number of workmen will not warrant a man being employed in that particular capacity, the placing of the lumber within easy reach is frequently overlooked. What is more exasperating to a workman than to stop in the midst of his work, and frequently be obliged to go out of the building, open up the kiln or dry house and get a board, if he has the misfortune to fail in getting out the required amount at the beginning of the job.

As our lumber dealers are not a very scrupulous lot, getting suitable lumber that can be worked up into patterns immediately is a game of chance, and unless a dry house or kiln is at your disposal, badly warped or unreliable patterns or a stock of lumber far in excess of the demand will evidently be found.

Common experience teaches that if the dry room be against the outer wall of the building and the necessary openings provided through the wall at the end of each rack, the lumber racks can then be so arranged that the racking of lumber can be done from the outside, and taken into the shop through the openings provided. Of course the first lumber in would be the first lumber used. It will be seen that this arrangement would provide dry lumber with a small lay out of stock, providing the racks were kept filled. With this mode of drying lumber a steam box for the heating of material prior to glueing can be easily arranged, as all that is required is the enclosing of one of the lumber racks and placing within this enclosure a series of steam pipes, providing the temperature of the dry house is not sufficient.

Assuming that the room is rectangular, the most convenient disposition is to place the work benches along one side and the machinery along the other, in the case of a small shop. By this arrangement the dust and shavings can be kept under control and the transmission of power to the machines is simplified. In the case of a somewhat larger shop where the dimensions of the floor are about equal lengthwise and across, the benches may be arranged along each side of the room and the machines placed in the center or at the end of the shop. In the case of a large shop a duplicate group of machines can be placed at each end.

The usefulness of machines depends largely upon the character of the work being done, and upon the condition in which they are kept. Fortunate indeed is the pattern shop that has a mechanic capable of keeping the machines in the best working order and at the same time making himself generally useful in the way of getting out lumber, glueing up material, etc.

A good speed for the line shaft is from 250 to 300 revolutions per minute,

XUM

as all wood working machinery requires high speed and a moderately high speed on a line shaft will be found advantageous, as it will result in smaller pulleys than if a lower speed of line shaft prevailed. The machines should be so located on the floor as to minimize the handling of the material. For instance, if the lumber can be brought in and passed over the rip saw, then over the jointer and back through a surface planer, it will always be kept moving lengthwise of the floor and the amount of handling minimized. After the work leaves the thickness planer it should pass to the cutting-off saw.

A blower system should be installed for taking the shavings away from the machines, and especially from the sandpapering machine, as the dust is not only detrimental to the health of the men, but a dusty shop is a bad investment for the firm, as the men cannot turn out so much work when they have to keep digging dust out of their eyes. Some of the outlets, or rather intakes, for the dust collector system should be located near the benches, so that dust and shavings resulting from hand work may be swept into them. These openings, when not in use, should be kept closed with a slide or hinge door.

The selection of machines is an important item and one which is worthy of a good deal of study. There are some machines which will pay a splendid rate of interest on their investment, even though they may be used less than an hour a day. A core box machine belongs to this class, for with it a man can produce in a few minutes results which it would take him hours to accomplish by hand, and at the same time turn out more accurate work. It is also bad policy to have one man waiting for another at the machines, for patternmakers' time is expensive and two hours time of a patternmaker will pay a good rate of interest on $12 per year. It can readily be seen that it would not take many such delays as this to warrant the duplication of a portion of the machine equipment. This is particularly true of band saws and small universal combination cross cut and rip saws, also of lathes.

The machine equipment of a shop doing a general line of work and employing 24 or more men should consist of the following:

At least four lathes, one of which should be a heavy combination or universal lathe capable of turning out face plate work up to 15 feet in diameter, and cylindrical or stave work to the diameter of 72 inches between the centers. There are several lathes of this design on the market. Another should be a combination face plate and tail stock lathe with power feed and an overhanging face plate which will swing work up to about six feet in diameter. It should also be capable of turning work 30 inches in diameter and 12 feet long between centers. One of the other machines should be a 16 or 24-inch lathe and the remaining one a small speed lathe. The speed of wood turning lathes will vary from 1,000 to 2,500 feet per minute at the surface of the work, and the accompanying table gives the number of revolutions recommended for various sizes of work. The great range of speeds given is due to the fact that in the case of very large work it is impossible to accomplish the high speeds. This is also true in the case of very small work.

The most important machine after the lathe is the band saw. At least two of these should be installed, one being a right-hand and the other a left-hand machine. It is also well to have one ordinarily equipped with a ¾-inch or 1-inch saw for ordinary segment sawing, etc., and the other with a ⅜-inch saw for light work with small rad.i. Band saws do good work when running at a lineal speed of from 3,500 to 4,000 feet per minute. Good results can only be obtained by keeping the saws in perfect order, and to accomplish this a filing and setting machine should be installed.

The jig saw or scroll saw still holds its place in many pattern shops for doing inside work, that is, for sawing out the inside of a closed figure. This saw,

however, is very slow in its action, as it is only cutting half of the time and then at a variable speed.

The circular saw equipment should comprise at least three machines. A swing or table cut off saw, rip saw table, carrying a saw 24 inches in diameter, and the other a universal table carrying two 14-inch saws, one a rip and the other a cross cut. Good results are obtained from a peripheral speed of from 3,000 to 10,000 feet per minute in the case of rip and cross cut saws working on dry white pine lumber.

Two joiners or hand planers are essential. One should be a 16-inch, and the other a 24-inch machine. The 24-inch machine should be arranged with a tilting table, which can be used for giving draft upon flat work. These machines should run at a speed of over 5,000 feet per minute. In many shops the jointer is used entirely for planing boards out of wind, but some still prefer the Daniels planer for this purpose, and recommend that it be included in any modern pattern shop equipment. It is certainly a very efficient machine in many ways, and especially for planing boards previous to passing them through the thickness planer. The cutters of a Daniels planer should run at a speed of from 10,000 to 11,000 feet per minute.

A surface or thickness planer is indispensable and should have a width of from 26 to 30 inches and be capable of handling stock from ⅛ inch to eight inches in thickness. It should be equipped with power driven upper and lower feed rollers. The speed is the same as that of the jointer or hand planer.

A vertical boring machine will be found very useful and will produce good results when equipped with Forstner bits in the way of depressing or routing out surfaces. This machine should be capable of boring holes up to two inches in diameter and arranged with a variable speed having a range of from 600 to 1,200 revolutions per minute.

A core box machine is another very useful tool in the pattern shop, as it will produce or dress out core boxes of any length and from ¾ of an inch to 22 inches in diameter. It can also be used for quarter turned, curved and straight work. Another use of the core box machine is found in the working out of the curved sides of staves, fillets, etc.

One of the most recent additions to the machine equipment of a pattern shop is the sand papering machine or universal sander. This consists of a disc covered with garnet sand paper and a spindle upon which rolls of different diameters covered with the same material can be placed. The variety of work that can be produced upon a machine of this sort is surprising and no pattern shop equipment is complete without one.

It is not necessary to dwell on the fact that trimmers are necessary. The only question is "How many?" There should be at least two large trimmers for general work and one of medium size located conveniently for use by the workmen occupying each pair of benches.

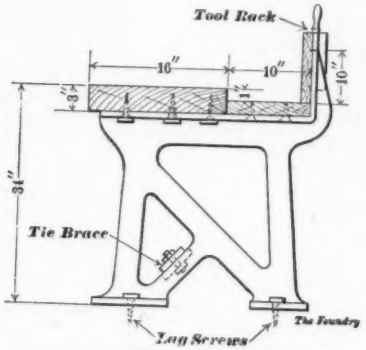
Many patternmakers prefer to make their own wooden dowel pins, and in this case a dowel pin machine should be included with a capacity for making pins varying in diameter by ⅛ of an inch from ¼ inch to 1¼ inches in diameter. There are several other tools necessary, such as an emery grinder for sharpening gouges, a grind stone, or water emery wheel, for other tools, etc., but these devices are so well known that no description of them is necessary.

Benches.

The benches should be uniform in size, say, about 26 inches in width, eight feet in length and 34 inches in height. The top of the bench should be supported by rigid cast iron supports or legs. These supports should be made with a bracket extending upward at the back, to which is secured the material forming the back of the bench and the tool rack which extends the entire length of the bench. This construction is shown in the accompanying illustration.

The working surface of the bench should be a 3-inch plank 16 inches wide, and the balance of the upper surface may be of 1-inch stuff so that it will be

lower than the working surface, thus allowing the front portion of the bench to be dressed off with a plane at any time. The legs or supports should be attached some distance from the ends of the



SECTION OF BENCH

bench, so as to prevent any sagging at the center.

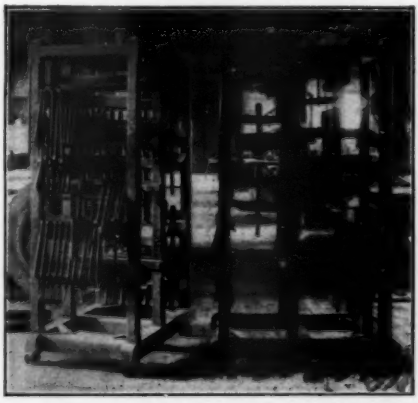
The bench should be equipped with a quick-acting universal vise and provided with a good spacious drawer, also with a set of bench stops. If the benches are placed along the wall, ample space should be left between them to receive the workmen's tool chests.

Parallel with each bench should be placed a work table and these should be of uniform height. A convenient size is 24 inches in height, eight feet long and four feet wide. By having the tables all of the same height, several of them can be moved together to support a large pattern when the construction of such work becomes necessary.

A large cast iron surface plate should be provided for building and testing work. A convenient size is four feet, three inches, by 10 feet. The outside edge should be surrounded by flanges nine inches deep, and the central portion of the plate supported by heavy ribs. The upper surface and the outer face of the flanges should be planed true and the vertical surface squared with the horizontal. The plate should be set level, so that work may be adjusted upon it with a spirit level. Parallel lines should be cut across the face plate while it is being made. Some prefer to have these 12 inches apart, while others prefer to have them three inches from each other.

A very handy piece of pattern shop equipment is a portable clamp rack, which is constructed to hold the various sizes of wood parallel clamps and also the iron clamps. Two of these racks are shown in one of the accompanying illustrations, and it will be noticed that they are mounted on casters, so that they can be wheeled to any part of the shop. There is very little about a pattern shop that is more unsightly than a lot of pegs nailed to the wall for supporting clamps. It is also exceedingly inconvenient to have to hunt over all the pegs and under all the benches for clamps when a man has to glue up a job. A rack of this kind will soon pay for itself in the saving in time effected in glueing up stock, on account of the fact that the clamps are always at hand.

For keeping track of the time spent on various jobs it is handy to use a regular Rochester time clock. This is independent of the clock used for keeping track of the total time which a man


CLAMP RACK

works. The same clock may be used for ringing up both sets of cards, but the cards for keeping track of the work

should be of a different color. They should be provided with columns for afternoon and forenoon, and also a column for overtime. When a man is given a job he is given a card and rings it up in the clock immediately. This card is then rung up at night and morning or at such times as ordinary cards are, until the job is finished. If a man has several short jobs in a day the sum of the time of the job cards should correspond with the time on his regular time card. If it does not, it shows neglect on the part of some one. Either a new job was not ready for him when his previous work was completed, or the workman neglected to ring up the job card immediately upon receiving it. In figuring the cost of work these job cards will be found very useful.

Practically the same results can be achieved by the use of one of the special forms of dating stamps, preferably a form which calculates and stamps the time when set to the beginning and finishing periods for the job. The advantage of the system first mentioned is that the Rochester time clock is very often used for keeping the men's time, and hence to put in use the time keeping system for work, all that is necessary is to provide the additional set of cards.

APPENDIX.

One of the members of the club, who always sees the humorous side of a subject, has contributed the following appendix to the paper:

The foregoing was dreamed by a patternmaker one night and he felt so pleased and contented as he imagined that he had all these devices at hand that he felt very much disturbed when his wife called up to him and said that if he was going to work he better get up, for he was already behind his time. He replied, "Oh, that's nothing, for the shop is behind the times, too." After a hasty breakfast, he went to work, and this is what he found.

Instead of a large, rectangular, well lighted and well ventilated room on the ground floor, with its 18-foot ceiling and no columns, he had to make his way up a rickety stairway (that was good enough today on account of the fact that it was good enough for the pattern shop twenty-five years ago) to the third floor next the roof. Here he found a dingy room, with small windows and a ceiling from ten to twelve feet high, the height being determined by the pitch of the graveled roof. There were heavy wooden columns about twelve feet apart, to support the roof, and incidentally to get in the way of anything that was being done in the shape of a large pattern.

To one of these columns was attached a post lathe, which was so constructed that when it was necessary to turn any job of more than six feet in diameter, the pattermaker literally took his life in his hands when he applied his tool to the work, because of the general shakiness of the floor and the building.

For the other equipment he had a fairly good lathe, which however, lacked all the modern fixings, such as slide rest, taper feed, cross feed, or any other of the handy appliances. In operating this lathe, he had to depend on the best skill of a good mechanic to finish a good job in good time in the old fashioned way.

Tucked away off in the corner, you could by looking close, in case the day was not too dark, or by turning on the artificial light, see a jig saw and a Daniels planer. The appearance and condition of the latter tool would make you wonder if this was not the same Daniel whose name it bears and who, according to history and fame, spent such a pleasant night with the lions in their den. (Please note that we do not mean the den of social lions of today.) The patternmaker could not help but wish that this machine was in the hands of its original inventor and that in place thereof he had that modern 24-inch joiner and 24-inch surface planer. There would be plenty of room for them because they would

XUM

not take up more floor space than the relic of by-gone ages.

There is one other machine in this noted equipment which we must not forget, and that is the old fashioned ripsaw, with a wooden table, and which you raise or lower to regulate the depth of cutting by means of a single screw. In other words, the whole table rests at one end upon a half-inch bolt and at the other is secured by two strap hinges. Just imagine these hinges with loose pins and then consider what accurate work can be done on it. But you know that you have a rip saw which, by a little ingenuity on your own part, can be made to do cross cutting, so you were told by the management that you had no need for a modern, up-to-date rip and cross cut saw, with its tilting table, indicators and other devices for getting out work quickly and accurately. You know that this is so, or at least you are told so, because you have been using these tools for years and your predecessors for more years than you care to tell about.

With these tools you have to compete with the pattern shop of your dream, which unfortunately is realized at your competitors' works. This means that nothing in the world but muscle and hard work can make any showing.

This is no exaggeration, as several of the members of the club have seen the shop and can testify to the truth of the statements, or tell of others quite as bad.

We are pleased to note a tendency today on the part of many manufacturers and shop superintendents to give more attention to the details and requirements of the pattern shop, to its location in regard to other buildings, to the building itself, and to the tools and machines with which it is supplied; also to the arrangement of the latter. We can, however, all point to a number of shops that should be remodeled on these lines and equipped throughout with modern equipment before they can be called up-to-date. For instance, we can all tell of the building which is so surrounded by others that one must conclude that in the making of patterns, light instead of being the first requirement is considered the last, unless it be that the manufacturers consider electric light cheaper than daylight, even if it is hard on the workmen's eyes.

In the matter of placing of machinery, we have known of a large lathe which, on account of the position of the existing line shaft, was so placed that all the light for the workman had to shine through his job. Now, we all know that wood of sufficient thickness for making patterns is somewhat opaque.

These and other examples of the lack of forethought in studying the requirements of a pattern shop could be multiplied from the experiences of the patternmakers present. We all know that the pattern making machinery runs at a high speed and in the course of years must get out of condition, but we also know how hard it is to get it repaired. It must be that the patternmaker foreman is a poor kicker or that these conditions are so common that custom makes us put up with them without grumbling to anybody except ourselves. We think, however, that it is time to kick for the very best that can be obtained and then look for results in the out-put of work from any body of patternmakers, large or small.

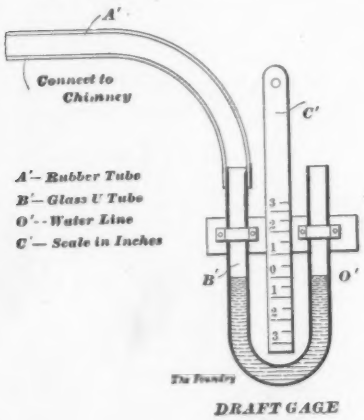
We hope that this paper will lead some of those who are responsible for the troubles of the patternmaker to see to it that their patternshop shall be as near up-to-date as it is possible to make it, believing that the ends attained will more than justify the expense in all cases.

COMPARATIVE DESIGNS AND WORKING OF AIR FURNACES.

BY RALPH H. WEST, SHARPSVILLE, PA.

The excellent articles on air furnaces by Mr. L. G. Blunt in the October, November, and December, 1905 issues of THE FOUNDRY led me to believe that if further data could be obtained, these might be compiled in a manner to interest many foundrymen. With this in view, reports were solicited from those who could assist in this work.

In soliciting these reports it was stated that they would be kept confidential and appear by numbers only. Nevertheless this will not prevent giving due credit to the firms that were so broad-minded and kind to render the service in question.



DRAFT GAGE

Fig. 1

There are many different designs of air furnaces, and all are governed by the experience derived in getting the flame most effective with the least consumption of fuel, to obtain the greatest durability in the lining of the furnace, the tonnage required, the character of the fuel, the supply of air, as well as the draft to obtain the best economy in fuel and speed in melting.

Some of the firms using air furnaces, and hence knowing their advantages, have from two to six in their foundry. There are firms who having two furnaces and requiring but one heat per day will run same alternately, others will take a heat out of the same furnace daily. The advantage of an air furnace over a cupola are: First, in enabling a founder to obtain lower sulphur in remelts. Second, in affording an opportunity to change the silicon, manganese, phosphorus or total carbon contents of the heat while in a melted state. Third, in permitting the obtaining of large bodies of "hot metal" at one tap. Fourth, in obtaining a stronger product from the same brands of iron through the refining action, freedom of contact from fuel, and the ability to manipulate the metal before it is tapped into the ladle. Fifth, in melting large bodies of broken castings or scrap that could not be charged into and melted down in a cupola.

It requires greater skill and care to operate an air furnace than a cupola. There is everything in working the fire, and every precaution must be taken to insure the iron coming down "hot" at the start. If this is not accomplished the temperature can only be raised by hard firing at the expense of loss in silicon, etc. A novice may attempt to take a heat out of the cupola and be successful, but should the same person try his hand at an air furnace, his chances would be excellent to make a very expensive fizzle.

Owing to air furnaces generally depending upon natural draft to promote combustion, the state of the atmosphere has much to do with the speed of melting, and obtaining of "hot metal." Again the same area and height of a chimney will not suffice for the same style furnace in all localities. The variations of surroundings in the matter of hills or high buildings that can effect the force of winds, can cause a more variable action in the speed and quality of the melting, than where a chimney is free from such influences.

In Fig. 1, there is shown a draft gauge that is a very valuable appli-

FIG. 2. CHARGING END OF FURNACE

ance to use. There are times when doubt may exist as to whether some trouble is due to the fuel, the draft, or the furnacemen; but by the use of such a gauge it is at least possible to define how far the draft was responsible for poor results and narrow the investigation to two factors, the coal and the melter.

THE FOUNDRY of January, 1906, has a valuable article by Mr. N. W. Shed, advocating the use of forced draft and heated air. He illustrates his idea which it will be to the interest of every one affected to study.

In taking up a review of the types presented herewith, the following firms are to be credited for tendering a report on the designs and workings of their furnaces:

FIG. 3. FURNACE DOOR

FIG. 4. TAPPING THE AIR FURNACE

Bethlehem Steel Co.'s iron foundry, South Bethlehem, Pa. Tendered by Mr. William J. Shannon.

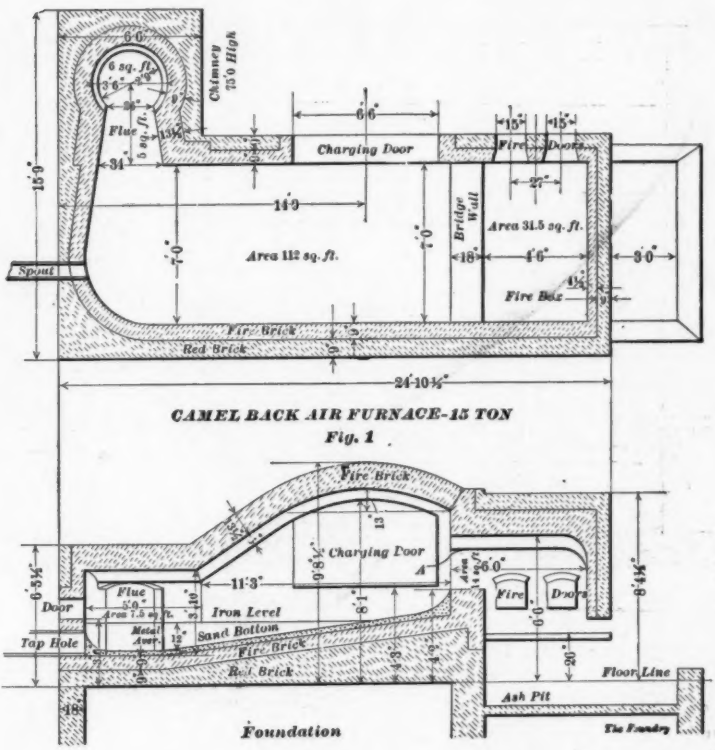
Buffalo Foundry Co., Buffalo, N. Y. Tendered by Mr. W. W. Shed.

A. Garrison Foundry Co., Pittsburg, Pa. Tendered by Mr. H. C. Shaw.

Lorain Foundry Co., Lorain, O. Tendered by Mr. Geo. F. Stoney.

Watertown Arsenal, Watertown,

FIG. 5. THE CHARGING BAR



Mass. Tendered by the commander, Major F. E. Hobbs.

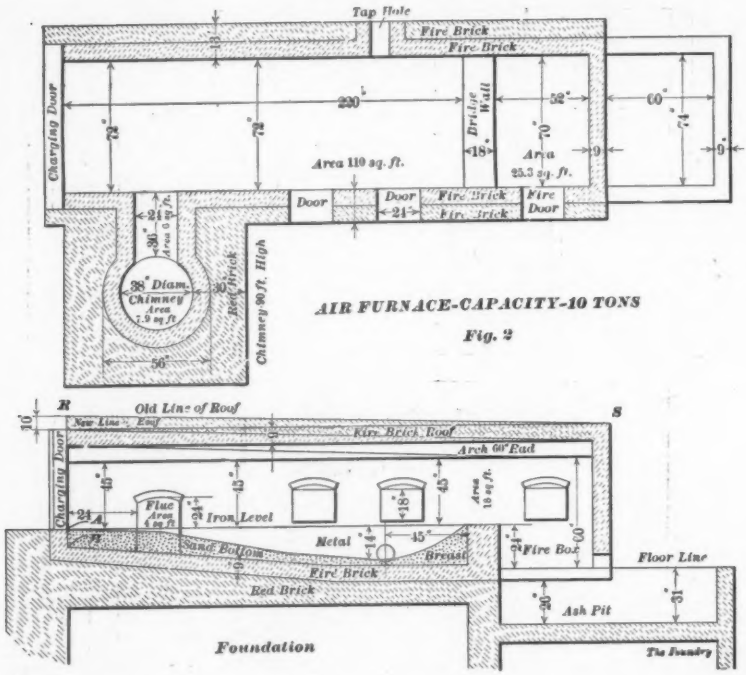
Westinghouse Machine Co., East Pittsburg, Pa. Tendered by Mr. W. A. Bole.

In taking up the furnaces in the order of their number, we first have No. 1, which is of the design known as the "camel-back." The firm owning this furnace has two of them and operates them alternately.

In making the bed or furnace bottom silica sand is used, the depth ranging 1½ inches to 6 inches according to the size of the heats, so as to always maintain the same level of slag line as far as practical. To make room for the large heats the minimum depth of sand is used. All the sand is never taken out, merely enough to remove such bodies as may cling to the slag. For ordinary heats about two wheel barrows of new sand will renew the bottom in good shape. Slab lumber is used to pile iron on and thus protect the bottom when charging the furnace. No trouble has ever been experienced with the bottom. The heaviest iron is charged right behind the bridge wall as near the fire place as possible, which by the way is the hottest place in the furnace.

The greatest burning out of the lining occurs in the throat right over the bridge wall in the top as at A.

Westmoreland county unscreened or "run of mine" gas coal is used. Every carload is refused if found to contain sulphur higher than 1.30. As a rule it ranges from .85 to 1.10. The melting ratio averages about 3½ pounds of iron to one of coal. It generally takes 6½



to 6¼ hours to melt down 24,000 pounds. The charge consists of old rolls and charcoal pig iron.

First iron commenced to melt about two and a half hours after starting the fire. The iron when all melted is very "hot."

It will be well to state at this point that the state of fluidity is designated as "dullish," "medium," "hot," and "very hot."

For patching material, fire clay, lake sand and pieces of old fire bricks are used. A whole new arch is needed at least once a year. The end charging furnace is preferred.

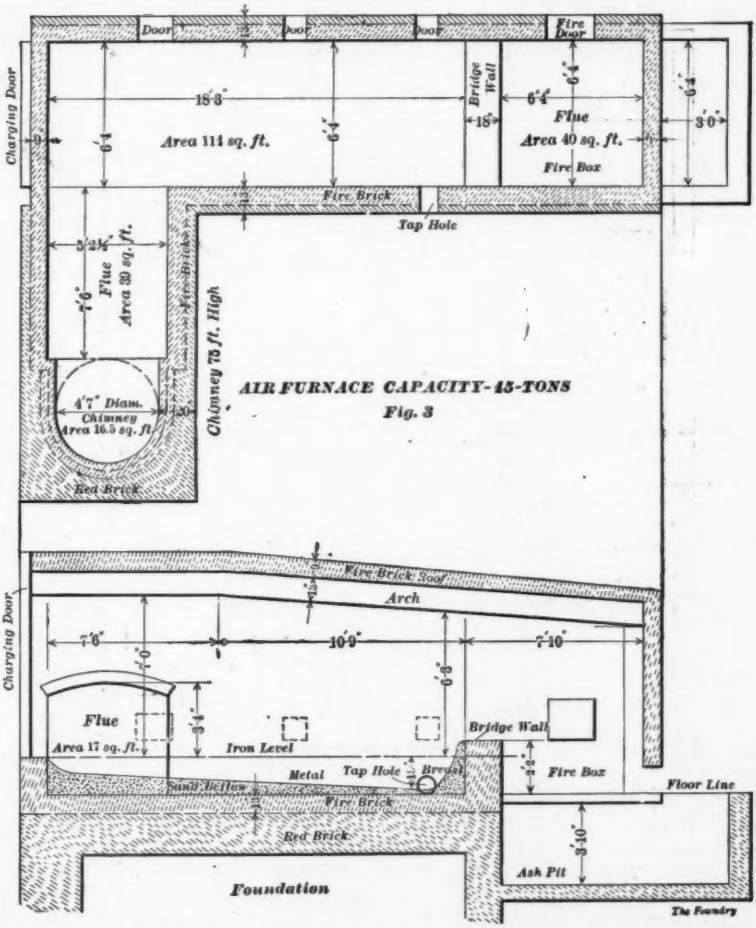
No. 2.

This furnace as shown has a straight level top. It was originally ten inches higher at the charging end as in keeping with the dotted lines R, S. The end at R was recently brought down to the level shown, because the flame drew along the top so much that good "hot iron" could not be obtained.

In filling the bottom a good brick foundation 13 inches thick was put in and then silica sand was put in about three inches thick at a time and burned the same as is done in open-hearth furnaces, until the shape required was obtained. For patching up any holes, sand the same as is used for cupola bottom is utilized. This silica sand was about 12 inches thick at the lowest place. No trouble has been experienced with the bottom and only at the tap hole where the cinder and iron remains after the cast is taken out, does it require any patching.

The heaviest iron is charged on the high part of the bottom, just in front of the flue. This is the hottest place in the furnace for melting.

For patching the slag line etc., a good ganister lining material is used and works very well. "Run of mine" Westmoreland bituminous coal is used, but the big lumps are broken to be no larger than a cocoanut when charged.



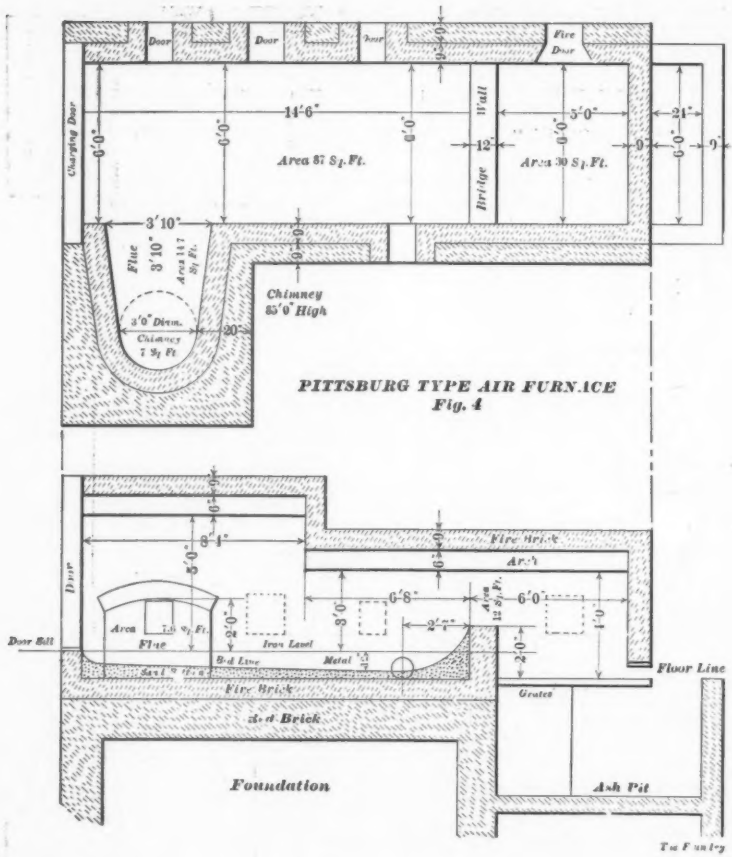
The greatest burning out aside from the slag line occurs at the flue entrance and between side doors.

A heat of heavy hard scrap and pig iron, taken April 19, 1906 gave ten and a half tons in six hours at the melting ratio of about 1 to 4. The first iron was seen to melt about one hour after starting the fire. The iron was not tapped until one hour and thirty minutes after it was all down, and was "very hot."

No. 3.

This furnace may be called a combination of the Pittsburg furnace and the camel-back. Accompanying the plan and elevation, views are shown in prospective in Figs. 2, 3 and 4. Fig. 2 shows the charging end filled with pig iron, and the furnace ready to be closed, with the charging door seen at Fig. 3. Fig. 4 shows the fire box end of the furnace and the metal tapped and running into a ladle.

The excellent and highly recommended beam that is used for this furnace (illustrated in the October 1905 issue of THE FOUNDRY) is shown in Fig. 5, and by virtue of this device, the heavy iron is charged up as close to

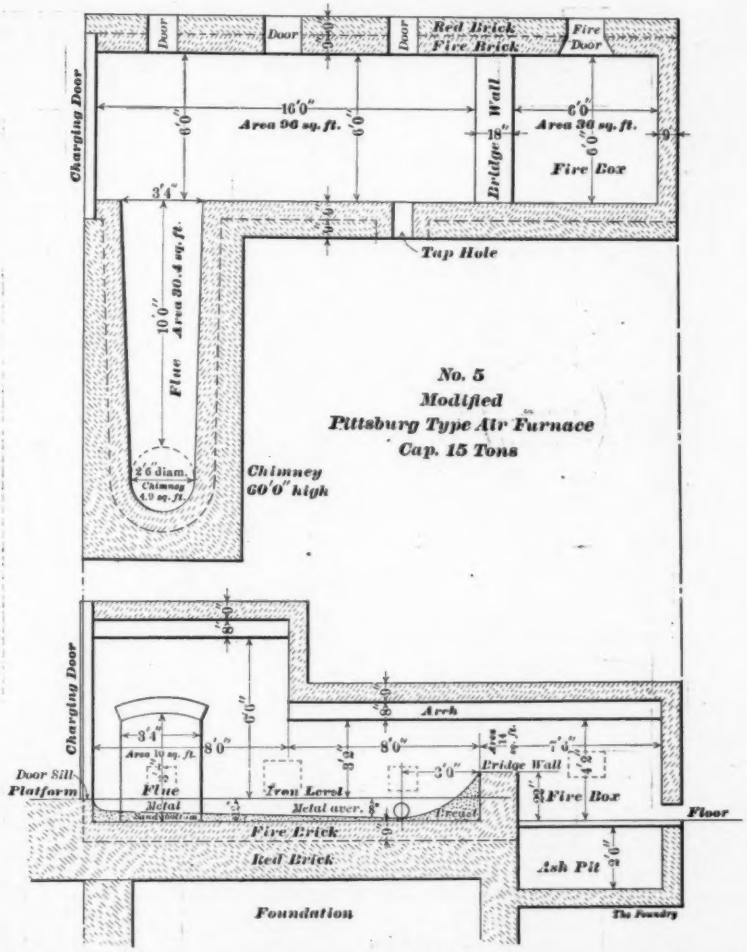


the bridge wall as possible. Those not having such facilities for handling heavy scrap would have great difficulty in attempting to do this with end charging furnaces. Burnt core sand taken from the chipping shop floor is used for making the bottoms.

A heat taken April 10, 1906, out of the furnace of firm No. 3, of thirty-five net tons was run down in nine hours. The first iron was seen to melt in forty minutes after starting the fire. The iron when all melted is reported as being "hot." The character of iron charged was heavy machinery scrap, weighing from one to ten tons each. For this heat 3 5-8 pounds of iron was melted with one pound of coal. A later heat of twenty-five tons used 12,705 pounds of coal or a melting ratio of 4 to 1; forty-five-ton heats have been melted down at the ratio of five pounds of iron to one of coal.

For a later heat than recorded above the device as shown in Fig. No. 1, was used for measuring the draft by entering the chimney near the base. When the furnace first started to melt, a ¾-inch draft was recorded and at the close of the heat when the furnace was the hottest, a one-inch draft existed.

It is stated that the hottest part of the furnace is just behind the bridge wall and from that point to about five



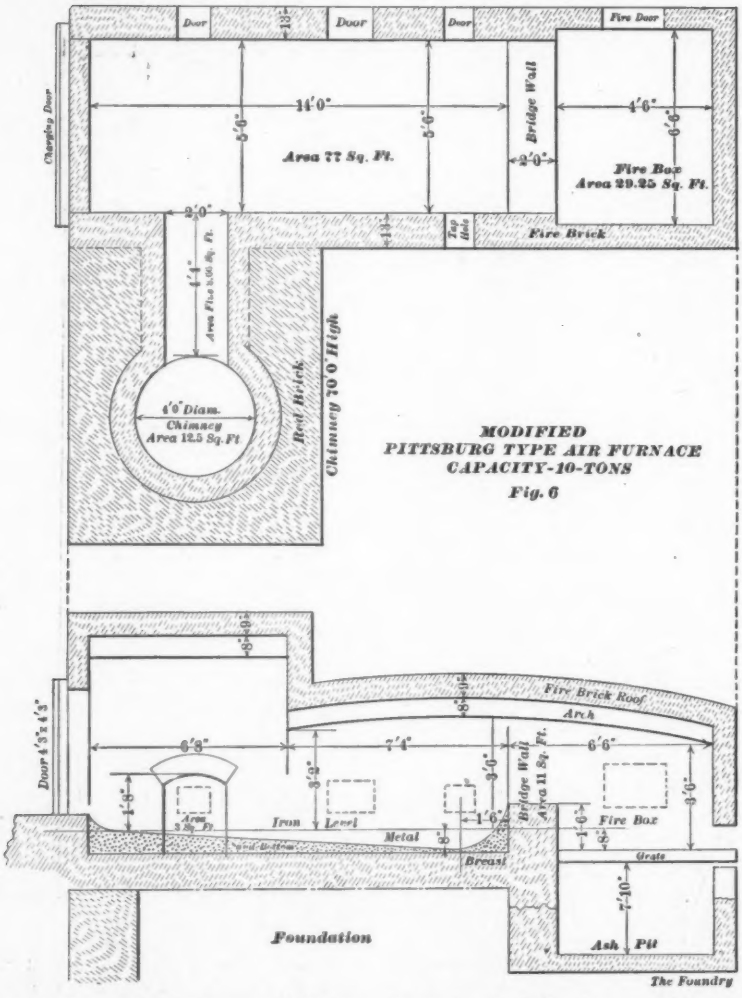
feet from the bridge. The greatest burning out of No. 3, is said to be on the sides of the fire box, rather than the roof. The furnace is run daily and the cost of lining or repairing, averages about $24.00 per month.

"Are now using two parts of silica sand and one part of fire clay, and making preparations to grind up fire brick bats to be used with fire clay for patching purposes."

Much stress is laid on the character of the roof shown. It is said:—"We believe this form makes a stronger roof and a stronger furnace; that the roof does not give way so easily; that the ease of charging is increased, and that in general it is superior to the usual method of making the roof in two distinct heights, as shown in the sketches Nos. 4, 5 and 6, which are modifications of the regular Pittsburg type.

No. 4.

This type of a Pittsburg furnace in the heat of April 18, 1906 melted down sixteen tons of gun iron, with seven tons of Penn gas coal. The iron was



seen to first melt one hour and fifteen minutes after starting the fire. The iron was melted "hot." When running this furnace to its full capacity, 22 tons, the ratio for fuel is quoted as 1 to 2.75. "We charge the heaviest iron at the middle of the furnace. Greatest burning out is found at the slag line and on the sides near the flue. Jersey fire sand and clay is used for patching."

"In a recent melt we determined losses in the following constituents:—silicon 0.17, manganese 0.18, carbon 0.035. The gains were:—sulphur increased 0.001 and phosphorus 0.014. The slight changes in sulphur and phosphorus may be due to error in chemical analysis.

No. 5.

The details of this furnace are based on average practice. The sand used for making the bottom is molding sand from the floor, which has been used

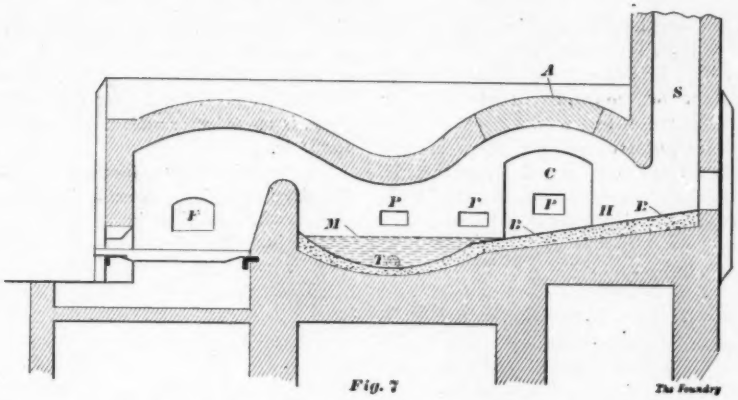


Fig. 7

and is put in from six to eight inches deep.

In charging the iron, half pig and half large scrap was used and melted down with select Youghiogheny coal at about the ratio of 1 to 3¾, in about seven hours. The first iron was seen to melt in about two hours after the fire was started. The metal is marked "medium" to "hot." Size of heat, fifteen tons. When the wind blows toward the open gate bars, the furnace works a little quicker. The greatest burning out, aside from the slag line is about the middle of the roof, half way between the bridge and the flue openings. For patching material, a mud made of one-half fire clay and one-half sand is used.

No. 6.

This furnace melts on an average nine tons in five hours. The hottest point is at the bridge. Burns out heaviest along the slag line. Use a sharp river sand for making the bottom in layers from four to six inches thick.

Nos. 7 and 8.

The illustrations are presented to show the designs of furnaces more commonally used in England, as is derived from views shown in "Modern Iron Foundry Practice," published by D. Van Nostrand Co., No. 8 being given the preference.

While it appears good logic that the air necessary to support combustion should in passing through the fuel be directed as much as upon the metal lying on the bed by the curve of roof, still for all this such designs as Nos. 7 and 8 would seem to be better

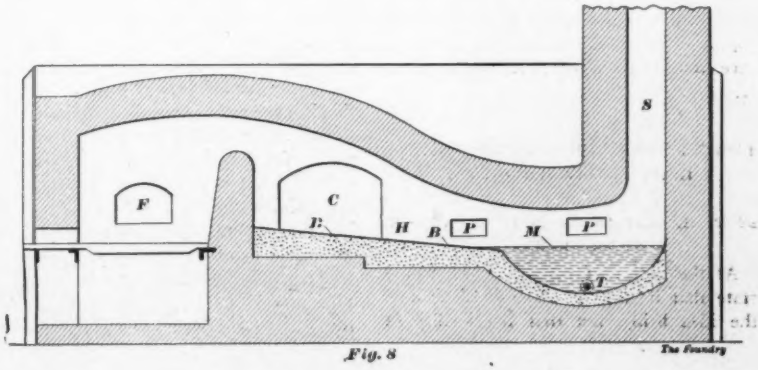


Fig. 8

in theory than in practice, when contrasted with Nos. 2 and 3, and shows us there is a tendency to simplify the contour or curvature of the interior roof lines of furnaces.

It is unfortunate that there are no data for the working of furnaces Nos. 7 and 8, as these would be valuable in enabling us Americans to know where we stand with our English cousins in the question of economy in fuel and speed in melting.

From what information can be obtained on the question of grate surface areas used some years back, it appears that it was figured to be about equal to that of the chimney. With our modern furnaces it will be seen by noting the areas given on the illustration shown, that the present day practice is to have a very much larger grate area, than that of the chimney.

Many different kinds of fuels such as wood, coke and hard coal have been used, but the latter two create such large quantities of fine ashes, that fall and cover the molten metal as to prevent the proper absorption of heat. The best kind of fuel is a fairly hard gaseous long flaming non-caking bituminous coal, that does not contain over one per cent in sulphur.

While there is much in preparing and charging a furnace that might be taken up here, this much can be said, that the operation of firing, to create and regulate a reducing or oxidizing flame, (the former being a heavy white flame, and the latter of a bluish cast similar to that which emanates from cupolas) is what requires the greatest care and skill on the part of the melter.

TWENTY YEARS IMPROVEMENT
In the Quality of Pig Iron.

BY

BY E. H. WILLIAMS AND E. R. SANBORN, SHARPSVILLE, PA.

At the outset of this paper we would state that its title is perhaps misleading, the idea being, not that the quality of pig iron of twenty years ago was different from that of today, but that the control of the manufacture, grading, shipping and use of pig iron, in foundry or steel plant, is much better understood now than formerly.

Nearly all blast furnaces making foundry iron today, have chemical laboratories, with chemists in attendance day and night. Careful analyses are made of all raw materials (ores, coke, limestone, etc.,) which enter into the manufacture of pig iron, and each cast is carefully analyzed for such elements as are likely to vary. The slags are also analyzed regularly and, in some cases, the waste gases from the furnace. This all means that the producer is in a position to control definitely the materials which are put into the furnace and to know exactly the character of the pig iron made.

This analytical work, to be of any value, must be carefully conducted by men of experience, which necessarily entails considerable expense, but for which the Furnace Company is amply repaid by smoother running of their plant and by the production of less "off" or bad iron, which they are obliged to dispose of at reduced prices, or remelt. In addition to this gain the Furnace Company is enabled to supply their customers with exactly the quality of pig iron they desire, and they are able to make and deliver iron suitable for all kinds of castings, whether they are to be strong, weak, soft, or hard.

As is well known, before the advent of chemical analysis as an adjunct to pig iron manufacture, foundry irons were bought and sold upon fracture grading alone. This is the case today in many foundries, but as the foundryman becomes better acquainted in a chemical way with the irons he uses, the fracture specifications are gradually being superseded by those of a chemical nature.

Now what is the reason for this? In our opinion the answer is, that, in judging the quality of pig iron, grading by fracture is entirely misleading. Irons of widely different chemical analysis have been graded as No. 1, No. 2, No. 3, with the different prefixes of Xs, softs and

strongs, and this work, generally, was supervised by a grader, usually a man who had no conception of the foundry business or the use for which the pig iron was intended, simply classifying the pigs by size and color of grain, and the softness and strength by the ease with which they broke on the block. Before the advent of chemistry irons for steel making were classified in this manner, the old Bessemer contracts providing that 60% of No. 1 and 40% of No. 2 iron would be accepted, the No. 1 iron being that with open grain, and the No. 2 being the closer grey iron. As the Bessemer process became better understood a phosphorus limit of .100% was established, this determination being among the first chemical analyses to be regularly carried on, it having been ascertained that irons higher than this in phosphorus made poor steel. Following this the Furnace Companies began to analyze their irons for other elements at irregular periods, once a month or once a week. Chemical analysis of iron was at that time a slow process. It usually took three or four days for the result to return to the Furnace Companies from the independent chemists, who made the analysis in their own laboratories, being located often in another town. Thus the iron was nearly always shipped before the chemical results were known.

As the steel makers began to see the advantage of controlling the chemical elements, other than phosphorus, in their steel, they began to buy iron on full chemical specifications, and this soon compelled the blast furnaces, which furnished them pig metal, to provide laboratories, and awakened the chemists to the necessity of devising quick methods, so that for the last fifteen or eighteen years we have been able to have a chemical analysis for silicon, sulphur, phosphorus and manganese of a cast of pig iron before it was loaded for shipment.

While the steel maker has found that the fracture of pig iron tells him nothing of its quality, nevertheless purchasers of foundry iron have been slow to disregard fracture grading, and up to very recent years little iron has been sold to them upon chemical grading. The reason for this was, probably, that the majority of foundrymen did not know the influence of the various chemical elements upon their castings, and the chemical analysis simply meant nothing to them. A number of the minority began to experiment, and so within the last few years we find more iron being sold on chemical specifications, and think it will not be long before the fracture grading will be entirely extinct. It is nearly so at the present time.

As an instance of the fallacy of fracture grading: We have had many casts of iron piled in our yard varying in silicon from .75% to 3%, and in sulphur from .009% to .050%, thus differing widely in character. It would be impossible for an expert to select from these irons, by its fracture, a cast approximating a certain chemical analysis.

We have in mind an instance where a blast furnaceman of the old school told an investigating foundryman that he could with a certain degree of accuracy estimate the silicon content of various pig irons by their appearance and fracture. The foundryman, desiring to test the furnaceman's ability in this direction agreed to put him on trial. With the bookkeeper carrying the record of analyses, they selected different casts piled in the yard. Several pigs were broken from each cast, and the furnaceman, from the appearance of the broken pigs, gave his estimate of the silicon content. The bookkeeper placed this estimate next to the actual analysis in each instance. On returning to the office the comparisons were shown, and the furnaceman was found to be entirely mistaken in the majority of the casts.

We have before us a communication from a prominent foundry iron manufacturer of Eastern Pennsylvania who gives us records of his earliest analyses of foundry irons, beginning in 1892.

The table below shows the variations in chemical analysis of these irons, of similar grades, covering a period of five years:

	Silicon.	Sulphur.
1892.		
No. 2X	1.20 to 1.58	.014 to .034
No. 2 Plain	.88 to 1.26	.034 to .052
Grey Forge	.66 to .96	.026 to .092
1893.		
No. 2X	.82 to 2.48	.010 to .039
No. 2 Plain	.54 to 3.17	.012 to .092
Grey Forge	.77 to 2.40	.041 to .092
1894.		
No. 2X	1.52 to 3.15	.009 to .020
No. 2 Plain	1.85 to 3.00	.010 to .040
Grey Forge	1.01 to 2.14	.021 to .068
1895.		
No. 2X	1.78 to 2.54	.003 to .042
No. 2 Plain	1.27 to 2.30	.025 to .067
Grey Forge	.66 to 2.14	.041 to .056
1896.		
No. 2X	1.67 to 2.62	.025 to .050
No. 2. Plain	1.57 to 2.53	.016 to .076
Grey Forge	1.29 to 2.35	.043 to .117

In a paper entitled "The Silicon Control of Carbon in Cast Iron", by F. E. Bachman, Buffalo, N. Y., read before the American Institute of Mining Engineers in October, 1898, several tables are given showing the variation chemically in different brands of the same grade of pig iron made by the Buffalo Furnace Company. The variations are given below:

No. 1X iron varies in silicon from 1.13 to 3.40; in sulphur from .013 to .053.

No. 2X iron varies in silicon from .67 to 3.30; in sulphur from .010 to .049.

No. 2 Plain iron varies in silicon from 1.05 to 3.21; in sulphur from .010 to .069.

If silicon and sulphur largely control the hardness and softness, strength and weakness of cast iron, these instances show the absolute fallacy of grades by fracture.

We have not touched upon the phosphorus and manganese content of foundry pig irons, as within ordinary limits they do not affect the fracture, and as the absence of these elements in the iron depends entirely upon the amount of them carried by the ore mixture. They are, therefore, uniform in any furnace using the same ore mixture, and foundrymen can specify the percentage of these elements required and feel reasonably certain of getting pig iron uniform in these elements. The silicon and sulphur are entirely controlled by the operation of the furnace.

Neither have we dwelled upon analysis for graphitic carbon and combined carbon, as it is now generally understood that the determination of silicon, sulphur, phosphorus and manganese are all that are required to properly classify pig iron for foundry use.

We have gone to considerable length to show the fallacy of fracture grading, as its use gives to the foundryman an iron of extremely indifferent character, while chemical grading is exact and irons of similar character can always be duplicated. Thus the control of the finished product has been improved. Without going into detail as to the improvement of blast furnace practice since the advent of chemistry we need but to say, that while formerly off iron was common, it is now possible to have a furnace make an immense tonnage without the failure of a single cast. A furnace running on Bessemer iron in the Shenango Valley had an entire year's product, nearly 100,000 tons, without a cast of pig iron over .050% in sulphur, which is the Bessemer limit for this element. Another furnace made over 50,000 tons without an off cast, and it is not common at well managed plants, particularly those that use good fuel, for the off iron to exceed 2% of the entire product. In an operation so crude, and yet so sensitive, these remarkable records are only attained by the careful selection and control of the raw materials. We all know that in the early days of pig iron manufacture in the South, it was extremely difficult to get iron there running under 5.00% in silicon, because of their lean, easily reduced ores and the large amount of fuel that they used. The chemist has shown them how, and now it is possible in the South to produce irons running uniformly under 1.00% in silicon for the basic process to high silicon softeners for the foundry.

There is no question but that our fathers made good iron. We make as good with the further advantage that when we sell a man a car-load that is par-

ticularly good, and he analyzes it, he can come back and find its duplicate.

In the foregoing we have endeavored to show that the application of scientific principles to the manufacture of pig iron has brought during the last twenty years a vast improvement in the control of its quality. The application of the same scientific principles to the mixture of various irons in foundry practice, will do as much to improve the uniformity of the quality of castings, and to enable the foundryman to make mixtures which will give him definite characteristics to the various castings which he seeks to produce. We would further call attention to the fact that for Blast Furnace Companies, the lower grades of iron, low in silicon, relatively high in sulphur, and low in graphitic carbon, or in other words, close grained, mottled and white irons, are produced more cheaply than the higher grades.

We believe that the time is coming when the foundryman will buy more of these cheap irons, and by the judicious use of alloys in the cupola, air furnace, or by adding to the molten metal, produce castings that are just as adaptable as those made from the higher grades of iron alone.

In Germany and Belgium it has long been the custom to utilize these lower grades in the basic process, the puddling process, and in late years it is being adopted for foundry practice.

The adoption of such principles will make of the blast furnace merely a reducer of iron ores to iron, allowing it to make more for quantity and cheapness, and depending on the scientific mixing of alloys to correct the poorer grades of iron which it shall make.

RECENT METHODS OF MACHINE MOLDING.

BY E. H. MUMFORD, PHILADELPHIA, PA.

I realize that I have said and written so much about molding machines that anything more from the same source would be unwelcome, as lacking in novelty, were it not that, like any explorer of terrae incognitae, I have but to describe what I have seen to be credited even with originality.

It is because I feel that I can tell you of some new things and some new combinations of old things, which I think are to make the year 1906 one memorable in the history of machine molding that I venture to address you again.

I may as well mention the fields of development, taking up the detail in those fields as I go. You will at once say that the *fields* are well known.

Broadly, this is true, for they are as follows:—

1. Rock Over Molding.
2. Jolt Ramming,
3. Match Plate Molding,
4. Multiple Molding.

So far as I know, Rock Over and Multiple Molding by machines are ten years old. Jolt Raming is over twenty years old, and Match Plates are the oldest thing in machine molding.

From the hinged flask to the first Rock Over Machine was but a step. Put the pattern on a Match Plate and hinge it from a point outside the flask area, with a counter-balance spring or weight to help handle the weight of plate and pattern, and a simple spring clamp to hold a bottom board on, and you have the earliest good seller in the Rock Over Machines. Its shortcomings are its radial pattern draft, which causes the pattern to bite off sand walls near the hinge especially, and the considerable error introduced by landing the mold on a more or less uneven bottom board. Mistakes have been made by designers putting brains and money into accurate pattern draft mechanism on machines, and afterwards vitiating all their designs by obliging their gear to draw a pattern from a mold which has tilted over on an uneven bed. You may know without trying that any machine that places a mold from which it is to draw a pattern on its back on a bottom board of any description and then draws the pattern regardless of the new plane of the mold joint will not be satisfactory on work involving any appreciable pattern drawing accuracy; and, even on the simplest work, if an absolutely clean

lift is wanted, this inherent error will prevent it.

Before going further, I may as well state that much that I mention in this paper either is already or will be patented, the foundry trade should be grateful to our beneficent Patent Law that allows public use and advertisement of a new idea without sacrifice of a Patentee's rights, for, by this condition, the trade get the use of the new machine just so much the sooner. It may be regrettable that enterprising foreign foster-mothers proudly adopt as their own promising American off-spring; but, after all, these infant wanderers seldom thrive away from home and the main regret is that they should be so abused and maltreated as to get an undeserved reputation for inanition. Of course, it is well understood by members of this Association that it is best to avoid appropriating other people's ideas which are in process of development for patents, and I will, therefore, not hesitate to tell you some of the good things I know.

A decided improvement in Rock Over Machines has been introduced by giving the hinge of the Rocking pattern support a rectilinear guide intended to be normal to the mold joint in its line of draft. This has been a most valuable innovation, but at present has in it the fundamental error I have referred to, of trying to get a fair lift from a mold lying on a bottom board, with a fixed pattern draft.

There are several easy ways of avoiding this difficulty, and one of these is already in use. I refer to taking the datum for the pattern draft from the joint of the flask. The half flask lies on its back on its bottom board, and the pattern is drawn by guides resting on the joint edges of the flask. This is the correct method and deserving of success.

Jolt Ramming.—Jolt Ramming is 20 years old in this country. If you consider merely the bumping of a mold to ram or partly ram it Jolt Ramming is as ancient as molding, for all bench molders have had occasion always to pick up a flask and bump it upon the bench to settle sand in the pockets. But, practically 20 years ago, S. Jarvis Adams had power Jolt Ramming machines running in Pittsburg on small deep flasks.

So it is not, in itself, a novelty, though some of the early patents upon it having now lapsed, its public use is only recently being advertised.

The canons of success in Jolt Ramming are:

A dead drop,
A firm, solid machine,
Center of impact under center of gravity of falling mass.
Impact always central.

Until recently, Jolt Ramming Machines which draw patterns as well as ram molds, have combined both functions in integral mechanisms and have been capable of ramming in only one way. Now, machines may be had which separate ramming from pattern drawing so that the ramming and pattern drawing elements may, if desired, be separately and simultaneously used, and, as a consequence, a variety of pattern drawing elements—or what are commonly called "Hand Ramming Machines"—may be used upon a single Jolt Ramming element.

Most of the work which it pays to Jolt Ram is so deep that, to draw patterns, stripping plates are required. To change stripping plate patterns on a machine requires considerable time. It is, therefore, often convenient to keep a set of stripping plate patterns which are frequently used, permanently fixed upon a pattern drawing machine. Moreover, there is no good reason for keeping an expensive Jolt Ramming Machine idle while men are changing patterns on a pattern drawing machine, which may just as well be separate from it. Furthermore, a man may purchase a single Jolt Ramming Machine, and add to it a variety of sizes of pattern drawing machines, and even use several of them at the same time on a Jolt Ramming Machine of sufficient capacity.

Ordinarily speaking, the cylinder of a pneumatic Jolt Ramming Machine is only large enough to raise promptly the weight imposed upon it. There is, however, no reason why this cylinder should not also be large enough to press a mold and be

subject to the control of an automatic valve for Jolt Ramming and, at the next operation, to an ordinary throttle valve for press-ramming.

To illustrate, take a grate bar. The pattern is all in the drag, and is of such a nature that Jolt Ramming is best, but the cope is "flat back," and must be rammed *upon the drag mold* and pattern, sand to sand.

This is something Jolt Ramming cannot do. The pattern in the drag will settle down in the sand away from the joint, so press-ramming is necessary. A machine is now built for this use.

Match Plate Molding.—I know you will say that this fell so long ago from the tree that the chestnuts cannot even be found in the burr! But don't forget that many a chestnut has grown a new tree!

Match Plates date from the good old days when molders actually did their own thinking, and studied out ways to save their employer's time. Theirs is an honored name, yet so many troubles have been laid at the door of match plates either ill-adapted for, or misused in their work, that many a man quits listening when you say match plates to him and begins to do the talking himself.

Probably the first successful use of Vibrators was in connection with single sided match plates, and there have been many applications of the match plate since then to machine molding.

The making of match plates with patterns cast in their surfaces by a process which constitutes the plate a fin of ¼" or more around the casting of the pattern s very old, though not even yet known to all foundrymen. In forming the edges of such a plate, any desired shape may be given to the casting. For instance, about six years ago aluminum match plates were cast with rabbetted edges to fit frames surrounding them, which carried the Vibrators and flask pins, and, with-that, now, there is little, if any, excuse for continuing the use of patterns feebly attached to the gates which run the castings.

This leads me to comment upon the fact that the match plate is deservedly rapidly displacing gated patterns in these days of speed in machine molding, for the gated pattern requires the sand match or odd side and separate ramming of cope and drag, which the match plate does away with.

Given a gate or spray of master patterns, and an aluminum match plate with edges fitted to go in a Vibrator Frame, may be prepared now in an incredibly short time by a new process which I am not permitted as yet to fully describe.

While speaking of match plates, if you will allow me, I will mention an arrangement which is not yet completed and working, for the simple reason of lack of time, but the working of which is so simple, though, I believe, so novel that I think you will pardon my speaking prophetically of its success.

It is simply a hinged match plate in a hinged flask. Hinged flasks are no novelty, and match plates would undoubtedly long ago have been used in hinged flasks, except for the disposition of the thickness of plate in closing, and the freeing of the hinge so as to get the match plate away. We give the flasks a double pin hinge and put the hinge of the match plate in one of them, so that the cope hinges on the plate until the pattern is drawn and then transfers its weight to its second hinge pin to free the plate. The plate is then hinged out of the drag and taken away, when its hinges are so arranged that the cope closes in perfect registration on the drag.

This method of molding avoids all handling of loaded flasks and reduces the "machine" to nothing but a match plate.

As a *hinged* match plate, however, it is limited to such patterns as will hinge out of both cope and drag, and is not for deep work.

Multiple Molding.—If I presented no development of Multiple Molding beyond what has been know ..to the trade for some ·en years, there would be little excuse for saying anything about it, but almost as much has been done in the last five years as was done in the first five of the approximately ten years of Multiple Molding.

The first Multiple Molds were just ordinary two part molds, piled one on another, with a sprue hole cut through the drag part into the cope part of the mold below.

Next came the thought of utilizing the idle joint between a drag part and a cope part.

It at once became evident that, in order to make this kind of Multiple Molds, it was necessary to ram both top and bottom faces of the Multiple element simultaneously. This meant that the drag patterns should be rammed down into a block of sand while the cope patterns were being rammed *up* into it. The impracticability of pressing a pattern down into a struck surface of sand had, long years before, been shown in the operation of a machine in Scotland in which a double-faced match plate was swung in edgewise between cope and drag flasks, the drag flask already filled with sand, the cope flask filled with sand dropped upon the pattern. In this machine, just as in Multiple Molding, until recently, the greater depth of the pattern had to be in the cope, and for the same reason—the common difficulty of getting sand *up* around the pattern, against the universally downward tendency of all things.

In 1902 Mr. P. D. Beckwith, at Dowagiac, Michigan, made a great improvement in Multiple Molding by providing for filling the drag pattern while inverted and then holding the sand up against the drag pattern while turning it back upon the sand already filling the flask upon the cope pattern.

Although doing this accomplished for the first time the ramming of deep drag patterns in multiple, yet the time occupied in handling the drag patterns separately was sufficient to very much reduce the otherwise rapid machine molding. There remained, however, the large saving in floor space and in sand and flasks inherent in Multiple Molding.

It would surprise the many who carp at Multiple Molding as a fad that has run its course to visit Dowagiac and see the kind of work Mr. Beckwith is making in this way.

And now comes Rathbone, with his new principle of neutralizing gravitation by causing the unrammed sand in the flask with excess sand enough in the removable sand frame over the flask to allow for compression to move *up* against and around the drag patterns fixed to the Ramming Block of the machine with velocity equal to what it would have had if it had fallen in upon them.

By this means, Rathbone sets the loose sand up around his pattern before ramming in an instant of time and just as effectively as though accomplished, as of old, upon an inverted pattern. In other words, he gets the drag mold practically instantaneously without the heretofore inevitable rolling over either before or after ramming.

If you will consider carefully what this means, you will see that a complete mold is formed by as simple and quick a process as is employed in other machine processes for forming the drag half alone.

As yet, the Rathbone process has been operated without time savers such as hopper-fed sand and automatically struck sand faces. But, notwithstanding this, sixty 14″x16″ or 13″x18″x4½″ molds an hour are easily made by one man who shovels his sand from the heap and stacks his finished molds eight or nine high.

As a rule, the flasks used for Multiple Molding must be about 15% deeper than the half flasks used in ordinary two part molding. This is because each flask has half of the cope and half of the drag patterns in it, and must have sand enough in its depth to allow for this.

Work of about 2″ total depth is usually piled nine molds high in flasks 4½″ deep. That is ten flasks—nine molds—in a pile.

The saving in sand and flasks accomplished under these circumstances is:

$$.85\left\{\frac{18-10}{18}\right\}37=\%$$

The saving in floor space is:

$$\frac{9-1}{9}=88\%$$

Most foundrymen think that the castings at the bottom of a pile in Multiple Molding must strain, owing to the ferrostatic head of, say, 45 inches.

XUM

Two things should be considered before assuming this:

FIRST.—That never were molds so perfectly clamped and weighted as those at the bottom of a stack of nine molds. If sand rammed as a liquid, and the same ramming pressure laterally as vertically might be assumed, the liquid iron would find walls of sand all about it set up at a pressure of at least 40 lbs. per square inch and held against displacement as never before. This iron, standing in a liquid column 45 inches high would exert a pressure less than 12 lbs. per square inch, so that, unless the walls of the molds yielded to such a pressure, and they would not, there could, even then, be no straining. But, the second consideration is that the usual guarantee against strained castings is had by so reducing the section of the gate which leaves the metal to the mold as to insure its having set before the column of metal in the sprue has risen to a height sufficient to put an excessive head on the mold.

While there are many more new methods of machine molding which I might mention, I believe that in the main the most interesting have been referred to. The perennial search for permanent molds is being made and it is barely possible, that, for light work, a permanent mold of refractory material that will allow a casting to shrink in it without pulling apart or that will follow the vagaries of cast iron in its process of crystalization may be discovered; but the problem is not an easy one, and I am inclined to think that for a long time to come green sand and a strong back or a good machine will produce most of our smaller classes of castings in large quantity.

THE LABORATORY EXAMINATION OF MOLDING SAND.

BY PROF. HEINRICH RIES., CORNELL UNIVERSITY, ITHICA, N. Y.

In connection with the utilization of any kind of mineral product, whether of metallic or non-metallic character, it is usually desirable to have some means of testing its value in the laboratory, so as to avoid a more costly test on a practical scale, if the material appears unpromising.

As a result of this we have well developed methods for assaying ores, for determining the chemical composition and heating power of coals, the crushing strength of a building stone, or the refractoriness of a clay.

There are, however, some mineral products, of no mean importance, which seem to have been neglected in this respect, and in this class, needless to say, we are obliged to place the molding sands.

The materials employed for making molds and cores in casting iron, steel, bronze, brass, etc., varv in character from a loamy clay to a sand or even gravel, being often, but not always of highly siliceous character.

For small castings, and for those on which it is desired to produce a smooth surface a fine sand is used, while for larger castings a coarser material is often employed.

Molding sands are not always used alone, and one or more grades are not infrequently mixed together, indeed the blending of molding sands is quite extensively practised now both at the pit and at the foundry. Even this, however, does not always give a mixture of exactly correct physical properties, and so certain foreign substances such as cinders, ground coal, graphite, molasses, flour, stale beer, linseed oil or straw are sometimes added either to increase the bonding power or permeability of the material. It is therefore seen that a sand in its natural condition may be deficient in certain qualities and yet by "doctoring" be greatly improved in quality.

The question may be reasonably asked whether it is possible to develope a set of standards to which molding sands used for different grades of work must conform. The problem is undoubtedly a difficult one, but still it may not prove as much so as one might expect.

If from a laboratory examination of a molding sand we can obtain at least some clues towards its possible applications, without having to go to the expense of time, labor, and material required for

TABLE II

Lab. No.	LOCALITY	20 Mesh %	40 Mesh %	60 Mesh %	80 Mesh %	100 Mesh %	100 %	Clay	Fineness	USES
35	Dye's Special, Ind.	.00	.06	.10	.04	.12	46.98	52.64	174	Malleable brass and gray iron.
8	Zanesville, Ohio	.10	.28	.56	.14	.36	46.64	51.70	163	
9	Albany, N. Y.	.00	.10	.20	.10	.20	71.22	28.16	143	
16	Zanesville, Ohio	.00	.16	.34	.12	.18	74.82	24.16	140	
43	Newport, Ky. (No. 5)	.00	.02	.04	.02	.14	77.54	22.12	140	Stove plate and brass.
52	New Albany, Ind.	.00	.10	.20	.10	.24	76.60	22.80	139	Malleable brass and gray iron, high grade stove plate.
57	Hamilton Co. O. (B. Y. No. 1)	.00	.10	.18	.06	.12	77.50	22.40	139	Stove and agricultural castings and brass.
55	Waterford, Ill. (No. 4 Grade)	.04	.06	.12	.06	.12	80.12	19.22	137	Malleable, gray iron and brass.
45	Newport, Ky. (No. 3)	.00	.06	.84	1.00	18.32	43.56	35.52	137	Light machinery and malleable castings.
32	Racine, Wis.	.00	.70	3.54	1.38	7.22	49.46	39.44	136	Small castings.
27	Rockton, Ill.	.00	1.12	10.68	1.86	6.82	46.38	32.86	134	Medium and heavy castings.
44	Newport, Ky. (No. 6)	.00	.00	.06	.06	.62	87.02	11.92	132	Light stove plate and brass.
54	Waterford, Ill. (No. 3 Grade)	.04	.42	3.90	1.92	6.12	56.72	33.02	131	Malleable iron castings, agricultural implements.
35	Neenah, Wis.	.00	1.26	4.26	1.40	5.64	32.04	35.14	131	Medium.
31	Rockton, Ill.	.00	.90	2.30	.70	1.84	74.02	18.50	129	Light gray castings.
17	Berlin, Wis. (No. 3)	.00	.76	3.74	1.78	10.44	62.96	20.06	125	
34	Neenah, Wis.	.00	.56	1.8	2.12	1 00	61.74	30.66	121	Brass sand.
21	Altoona, Wis.	.44	2.82	5.76	1.44	2.86	51.96	33.46	119	Saw-mill casts, sleigh shoes, repair, and sash weights
51	St. Joe Riv. St. Joe Co. Mich.	.00	.54	11.68	2.78	16.58	43.42	24.52	110	Small gears, malleable iron, brass, car journals.
24	Berlin, Wis.	.00	1.46	9.78	3.52	14.86	47.48	22.86	109	
19	Berlin, Wis.	.00	1.76	10.44	4.50	14.52	45.42	20.64	106	
36	Menomonie, Wis.	.54	2.74	5.44	.82	3.74	76.86	9.16	106	
7	Berlin, Wis.	.00	.36	6.56	3.52	21.22	64.84	2.56	105	
49	Indiana (No. 1)	.04	.66	11.42	8.12	20.64	35.40	23.42	105	
28	Berlin, Wis.	.00	.54	8.50	5.34	19.14	60.64	4.80	103	
22	Grand Rapids, Mich.	.00	1.98	21.76	6.56	14.06	30.16	24.96	93	
37	Marinette, Wis.	2.08	3.68	12.06	4.26	9.22	39.14	29.10	92	
47	Indiana (No. 3)	.06	.62	18.76	9.02	23.48	33.26	12.82	92	Light machinery and malleable iron.
26	Neenah, Wis.	.00	2.02	20.78	7.32	15.96	38.70	14.54	90	
48	Indiana (No. 2)	.00	.94	18.18	8.54	29.96	34.22	7.94	88	Machinery sand.
29	Racine, Wis.	.00	1.04	11.74	5.80	28.48	46.08	6.60	86	Fine core sand.
23	La Crosse, Wis.	.54	7.72	13.00	1.94	8.34	49.76	18.10	86	
33	Racine, Wis.	.00	.72	24.68	11.78	26.60	19.20	16.30	86	Heavy castings.
56	Valparaiso, Ind.	.26	3.56	26.08	10.06	17.70	15.10	27.12	83	Large pipe, fittings and structural iron.
1	Berlin, Wis.	.10	3.26	23.82	8.32	26.04	37.32	1.02	83	Core sand.
4	Pardeeville, Wis.	.00	.36	23.76	9.50	35.76	30.22	.36	82	General work.
25	Janesville, Wis.	.00	4.00	28.72	8.48	22.54	21.22	14.84	78	Core sand.
20	Wheatland, Wis.	1.26	18.94	2.26	23.70	29.86	8.96	14.00	76	
6	Massillon, Ohio	3.40	1.36	12.52	11.98	39.16	24.66	6.50	74	Heavy castings.
15	Klondike, St. Charles Co. Mo.	.00	4.54	41.98	13.78	21.12	15.76	.66	73	
41	Janesville, Wis.	1.66	7.70	25.20	8.12	17.68	21.42	18.20	70	Heavy work.
11	Fairwater, Wis.	.00	4.86	34.46	8.06	29.38	22.58	.16	68	
12	Fairwater, Wis.	.00	7.76	32.82	7.24	30.06	21.96	.32	66	
50	Kenosha Co. Wis.	1.32	14.02	28.68	5.62	10.24	14.12	24.02	63	Heavy machine castings.
65	Milwaukee	3.56	5.47	28.41	10.61	27.76	22.75	Tr.	62	Core sand.
5	Pardeeville, Wis.	1.80	9.08	35.68	7.94	13.90	19.78	11.04	62	General work.
10	Pardeeville, Wis.	.00	5.92	42.00	11.64	22.58	12.76	5.06	62	General work.
13		.00	.94	66.04	7.00	15.84	6.46	4.22	62	
2	Wheatland	5.99	9.18	21.80	5.86	8.81	13.72	27.36	58	
46	S. Milwaukee	6.90	11.44	27.76	8.76	14.10	12.47	18.52	54	
58	Illinois Steel Co.	.10	7.10	62.02	10.05	10.54	6.92	2.32	53	
40	Kerrick, Minn.	6.00	8.20	19.96	4.92	11.04	31.72	10.30	49	Green sand casting, general heavy work.
14	Ottawa, Ill.	.00	40.28	41.28	2.92	7.46	5.82	1.48	40	Steel castings.
30	Janesville, Wis.	.40	16.54	56.24	5.60	5.20	2.60	13.34	40	Cores and heavy work.
39	Madison, Wis.	11.66	21.98	43.82	7.50	9.02	4.12	1.66	39	
42	Superior, Wis.	12.76	35.06	40.56	5.72	3.24	1.54	.40	32	Pipe cores.

putting the sand through a practical test, much will be gained.

Unfortunately but little has been published on this subject in the past. Many books on foundry practice give but little attention to the value of a chemical analysis, although a few suggest that further chemical investigations would be desirable. A physical examination of the material is rarely referred to.

This lack of previous laboratory investigations might lead some to suppose that such methods were of little value, and even the foundryman in many cases looks on them with discouragement. Such action should however but serve as a stimulus to probe the matter more deeply, and not give up until it is definitely proven to be valueless.

In practical work the foundryman is accustomed to give a moist sand a preliminary examination by pressing it in his hand to see if the particles cohere, or to hold it between his hands and blow through it in order to test its permeability, and the acceptance or rejection of the sand sometimes hangs on this simple but insufficient test.

Even assuming however that laboratory standards for determining the uses of a sand are of little value, they might still have another application, vis., that of keeping check on the material being received from any one pit.

It is well known that the sand in any one deposit does not always run perfectly uniform in its character, or there may be carelessness in the sorting of the material from different beds in the bank. This may show up in the behavior of the material at the foundry. Now if each shipment is examined either physically or chemically, or both, variations can in most cases be detected, before any castings are spoiled. Of course a certain amount of variation is permissible, and even unavoidable, but it should not be increased by careless mining or mixing of the raw materials at the pit.

During the past year the writer has had occasion to make a study of some of the molding sands used in Wisconsin, and as a result of this work, he takes pleasure in offering a few facts to the Association in the hopes that they may at least provoke discussion, and bring out suggestions regarding possible methods of testing these materials in the laboratory.

As is well known the sands used for molding, can be separated into two groups, viz. those used for making the mold, into which the metal is poured, and those used for the core, which fills up hollow spaces.

Considering the molding sands as a class, we find that the requisite qualities usually mentioned are:

1. Proper texture.
2. Permeability.
3. Sufficiently long life.
4. Moderate refractoriness.
5. Sufficient bonding power.

Texture—The Texture of the sand or percentage of grains of different size is determined by a sieve test, this being done by passing the sand through a series of sieves of decreasing mesh and and noting the percentage which remains on each sieve.

The sands may be sieved either dry or wet. If the sizing is done on dry sand, it is found that some clay particles adhere to the sand grains, and therefore the percentage of the several sizes is greater than it should be.

A method used by Mr. W. G. Scott of The J. I. Case Threshing Machine Co. of Racine, Wis., consists in placing ten grams of sand on the 100 mesh sieve, along with ten 7-16 in. steel ball-bearing balls, and shaking with a circular motion for one minute. The sand passing through is weighed and credited to the 100 mesh sieve. The sand remaining on the meshes of the sieve, together with the balls is emptied onto the 80 mesh sieve, the operation repeated, and so on up to the 20 mesh. With this method he claims less work is required and the results are more accurate.

The method adopted by the writer for the Wisconsin sands was as follows:

Fifty grams of the sand were put in an eight-ounce bottle, and the latter half filled with water. This mixture was then put in the shaker for four hours, after which it was washed through a set of 20, 40, 60, 80, and 100 mesh sieves. The sand retained on each was dried and

weighed. That which passed through the 100 mesh was caught in a jar. When all the water and suspended matter had been run through the sieves the contents of the jar were stirred up, and after standing 45 seconds, the water with suspended clay and fine silt were decanted off. More water was added, the contents of the jar stirred and the decantation repeated. In this way two sizes were obtained. That which remained in suspension has been termed the clay and that which settled is indicated as 100+, and most of it is retainable on a 150-mesh sieve.

Some objection may be raised to shaking the material before sizing, because of its tendency to destroy some of the loosely cemented compound grains. It is probable, however, that in tamping the sand into the flask for casting, that many of these would be broken up. Those that are too hard to be thus crushed are likely also to resist disintergration in the shaker It was found, however, that several of the sands analyzed contained compound grains in the 20, 40 and even 60-mesh sieves.

In the work on the Wisconsin materials about fifty molding sands were analyzed mechanically, and the limits of variation of the different sizes are given in Table I.

TABLE I.

Size Mesh.	I Percent.	II Percent.	III Percent.
20	0 — .04	0 — 6.	0 —12.76
40	.02— .90	.16— 9.08	.72—35.06
60	.04—2.3	.34—42.00	19.96—56.24
80	.02—2.2	.12—11.64	4.92—11.78
100	.12—1.84	.18—39.16	3.24—30.06
100+	46.98—87.02	12.76—76.86	1.54—37.32
Clay	11.92—52.64	.36—35.52	.4 —18.26

I. Brass sands.
II. Sands for general work.
III. Core sands.

An examination of the above figures shows that the fineness of each group varies in two cases at least between rather wide limits, and as we might expect there is some overlapping. That is to say that some of the sands used for general work are coarser than some of the sands used for cores. This is however to be expected. No one grade of sand can be used for all kinds of castings. Considering the average fineness of each group however, we see that the brass sands are the finest, the sands for general work the next, while the core sands average the coarsest.

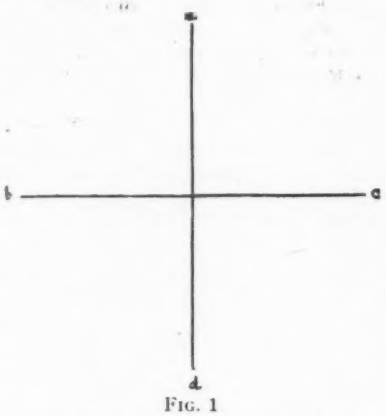


FIG. 1

In Table II are given the mechanical analyses of all the sands examined, together with their fineness and uses.

While it is possible to use these analyses for purposes of comparison it is sometimes rather slow work where a large series of analyses are being considered. If therefore we can devise some graphical method of showing the texture such comparisons can be more rapidly and satisfactorily made.

Fig. 1. Represents the method adopted. On the four lines, a, b , c, d, there are laid off equal distances, corresponding to 100 per cent. On a, the percentage of clay is laid off, on b the amount of 100, on c the percentage of 100+, and on d the combined percentage of 20, 40, 60, and 80 mesh grains. These last four are combined as they represent the coarse particles of the sand. Having laid off the proportionate distances on the four lines, the points are connected by straight lines, and the resulting figure shows at a glance the structure of the sand.

Plates I, II, and III, represent the texture of all the sands examined, and includes several well known sands from Ohio, Indiana and Kentucky. In the very fine ones it will be noticed that most of the figure lies above the horizontal line bc,

XUM

while in the very coarse ones they lie below the horizontal.

For example, in Plate 1 one can tell at a glance that Nos. 53 and 8 are practically identical, and that Nos. 45 and 32 are very closely alike.

Since the mechanical analysis is a rather detailed and lengthy mode of stating the texture of the sand, it is evident that if the fineness can be expressed by means of a single number it would be much more convenient. Such a number must however represent the average fineness of the sand.

This average may be defined as the sum of all the quantities considered divided by the number of separate items.*

Now if in a sand we have
N_1 grains of size S_1.
N_2 grains of size S_2.
N_3 grains of size S_3.
etc.

Then

$$\text{Average size of } S = \frac{N_1S_1 + N_2S_2 + N_3S_3 + }{N_1 + N_2 + N_3 + \text{ - - -}}$$

If the total number of grains is N then

$$N_1 + N_2 + N_3 + \text{ - - - } = N$$

$$\text{And } S = \frac{N_1S_1 + N_2S_2 + N_3S_3 \text{ - - -}}{N}$$

$$\frac{N_1}{N}S_1 + \frac{N_2}{N}S_2 + \frac{N_3}{N}S_3 + \text{ - - -}$$

But $\frac{N_1}{N}$ the fractional part of the whole quantity which has a size S_1. So if the total number is taken as 100 (or proportional to 100) $\frac{N_1}{N}$ = per cent of size S_1 and $\frac{N_2}{N}$ = per cent of size S_2.

In order to apply this formula to the mechanical analysis of a sand it is necessary to assume an average size for each mesh. In the case of the grains retained on the 20 mesh, it was assumed that they averaged 1/15 in., as few of them were much larger. This size would then be expressed decimally as .066.

Those which rested on the 40 mesh, might range from 1/20 to 1/40 inch. and their average was taken as approximately $\frac{\frac{1}{20} + \frac{1}{40}}{2}$ = .037 and so on. The average size grain of the 100 size was taken as $\frac{1}{100}$ in. or .008, while that of the silt as clay was assumed as .004.

As an example:

The mechanical analysis of one sand was:

Mesh.	Per Cent.
20	.44
30	2.82
60	5.76
80	1.44
100	2.86
100+	51.96
Clay	34.46
	99.94

.0044 x .066 = .00029
.0282 x .037 = .00104
.0576 x .019 = .00109
.0144 x .013 = .00019
.0286 x .011 = .00031
.5196 x .008 = .00415
.3446 x .004 = .00137

.00844 average grain size

$\frac{1}{.00844}$ = 118 mesh.

In other words, if all of the grains of the sand whose mechanical analysis is given above were reduced to a uniform size, they would pass through a 74 mesh. The average fineness of the sand is given as 74.

It will be seen from an inspection of Plates I and III that the average fineness of the sands examined ranged from 174 to 39.

Permeability and Porosity—By the permeability of the sand is meant the property which it possesses of allowing liquids or gases to filter through it, and it depends therefore on the size of the pores.

By porosity is meant the volume of pore space between the grains.

These two properties are therefore not the same. A sand may contain a few large openings through which liquids or gases might easily escape, and yet have a small total pore space. On the other hand its total pore space might be large,

*The method of calculating the average fineness of a sand has been suggested to the writer by Professor J. S. Shearer of Cornell University.

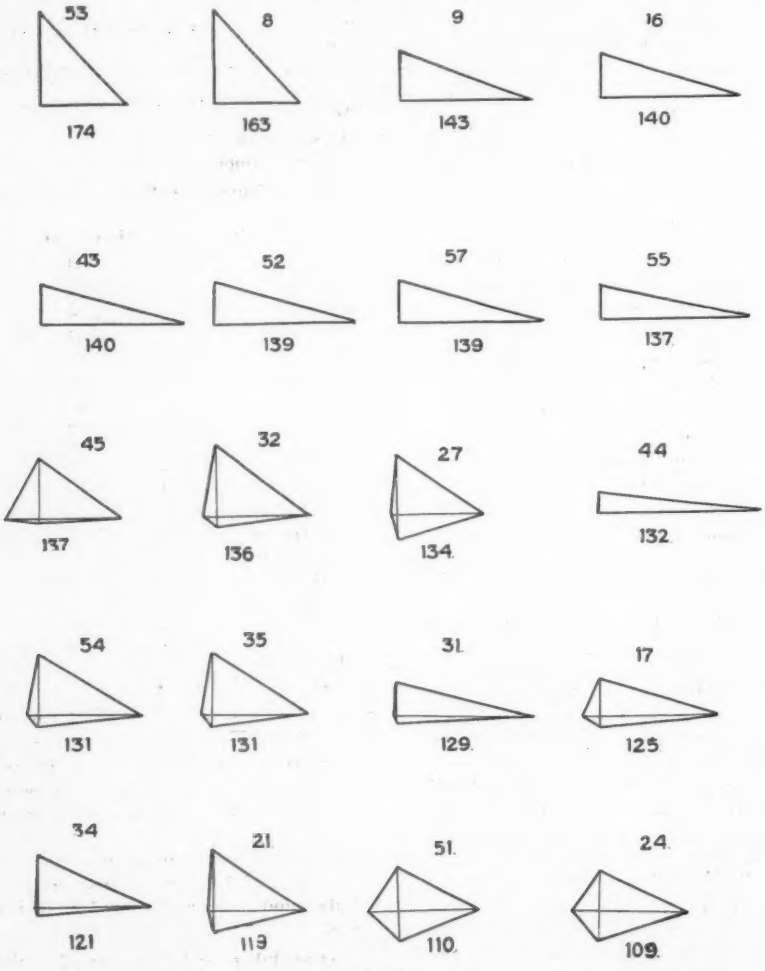


PLATE 1

but owing to the small size of the pores permeability by either gases or liquids becomes difficult.

The permeability of a sand might be influenced by three things, named in the order of their probable importance:

1. By the tightness of packing.
2. By the size of the grains.
3. By the fluxing elements of the sand.

In discussing the effect of 1. two cases must be considered, (a) that of a sand whose grains are all of the same size, and (b) that of a sand whose grains are of unequal size.

If a given amount of sand is placed in a cylinder it will occupy a varying volume of space depending on whether it is tightly or loosely pressed in, and the closeness of the packing may be increased by tapping the containing vessel. This gets the grains into their closest arrangment, producing the minimum pore space.

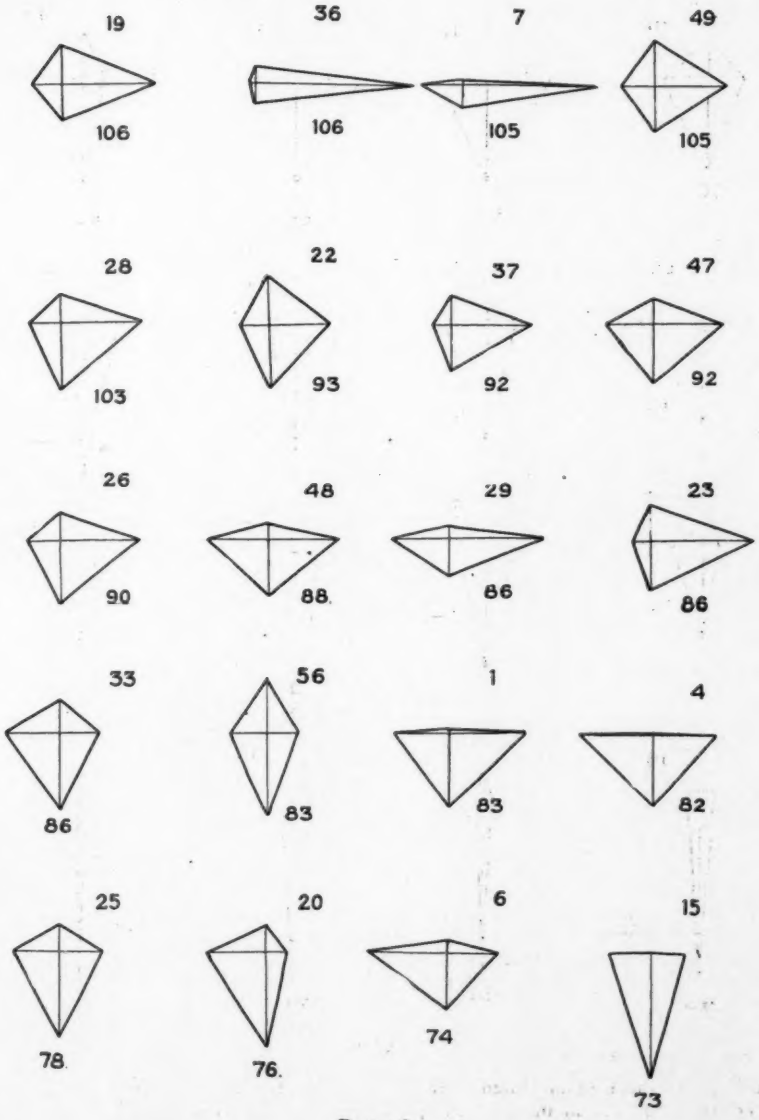


PLATE 2

The amount of pore space produced in this manner however is dependent somewhat on the shape and size of the grains.

In order to make this clearer it is necessary to assume somewhat ideal conditions. An ideal sand would be one composed of spherical, uniformly sized grains, and the amount of porosity will be governed by the arrangement of the grains. Thus comparing Figs. 2 and 3, the most compact arrangement is that shown in Fig. 3, in which each grain

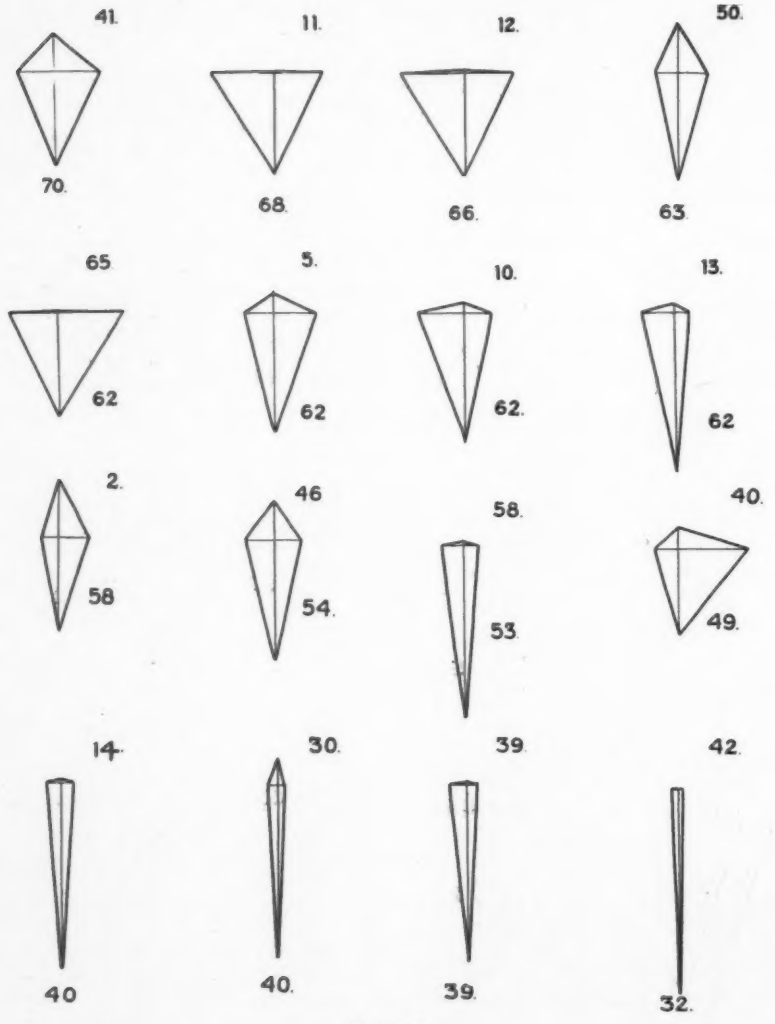


PLATE 3

touches 12 other grains (19th Ann. 11: 306, et. seq.), and in this case the pore space would equal 25.95 per cent. If however each sphere touches 6 others, the maximum pore space is developed, and equals 47.64 per cent.

It makes no difference, what the diameter of the spheres is, (provided these are all of the same size), the pore space will remain the same, with the same arrangement. With smaller spheres however, the pores will be smaller, and hence the permeability less.

Such ideal sands are practically unknown in nature, but fine grained sands are more apt to approach theoretic porosities than the coarse grained ones.

In nature the conditions are quite dif-

ferent, and the sands commonly found contain not only grains of irregular size but sometimes of angular character.

The investigations of King* have shown that the finer grained sands have a larger pore space than coarser-grained ones, even though composed of approximately equi-sized grains, and that if the grains are angular, the pore space for any given size is increased because angular particles will not pack so well. The minimum pore space was obtained by using two sands of rounded grains but different diameters, and mixed in equal parts.

In connection with grain size, there is probably one factor which is lost sight of, and that is the state of aggregation

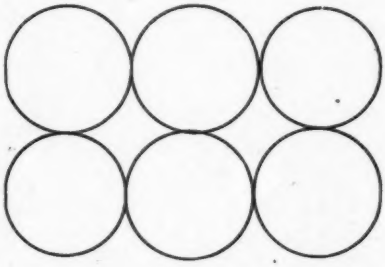


FIG. 2

of the finer grains of the sand, whether they be silt, or clay. If these are separate, they will pack much closer, and tighter, than if cemented or bunched together in the form of compound grains.

If in the latter condition the porosity of the mass would be larger, and the permeability also, than if the grains were separate. In the mechanical analysis of the sand the grains undergo some rubbing, and these compound grains may therefore be destroyed to some extent.

The above brief discussion of the porosity of sands is not of purely theoretic value, but has several important practical bearings, for from it we see the means of increasing or decreasing the porosity of the sand somewhat. Thus tamping, because of forcing the grains together decreases the pore space, but even so theoretic conditions can rarely be reached.

*19th Ann. U. S. G. S. 11:209-215.

Other things being equal, sands of varisized grains pack closer than those of equi-sized grains.

The decrease in permeability under increased tamping explains why some good sands behave badly, when packed too tightly, in the mold, refusing to allow the gases to escape, and causing blowholes.

The permeability of a sand is also influenced probably by the amount of water used in packing the sand. Foundrymen usually add a minimum quantity of water to the sand, in fact just enough to make it cohere sufficiently, it being claimed by some that an excess fills up the pores of the sand, and thereby decreases its permeability. While the addition of too much water may do this, the effect is

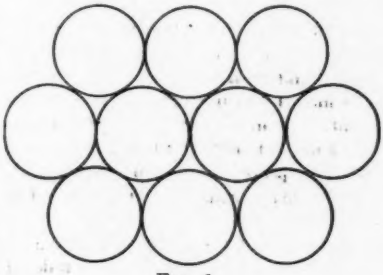


FIG. 3

probably an indirect one, and is due to the fact that wet sand will pack denser than dry sand. This closer packing will consequently decrease the pore space.

The relation between fluxing impurities and permeability is one which may show itself during the casting. If the clayey particles filling the interstices of the sand are sufficiently impure to fuse when heated by the cast metal, the coalescence of these in melting will have a tendency to close up the pores to some extent at least. For this reason partly a high percentage of fluxing impurities is found undesirable.

The proper permeability of a molding sand is a matter of vital importance, since it permits the gases to escape while the metal is being cast. These gases may be given off by the metal, or may be steam produced by the heat action on the moisture in the sand. A pathway must

therefore be open for their escape, and if none is at hand blow holes are formed.

Since the degree of porosity of the sand is therefore an important matter, it becomes desirable to have some accurate means of measuring this if possible, and while several investigators have turned their attention to this problem, the results obtained have not been wholly satisfactory.

King has shown that the permeability as indicated by "the time necessary for 5,000 cu. cm. of air to pass through a given sample holds no very apparent relation to the pore space, which was found, except, indeed, that generally the larger the per cent. of pore space the slower the air was in passing through." In other words the finer the sand, the lower its permeability.

From this one might assume a general but not very close relation between pore space and permeability.

Since the measurement of the permeability of sands is more or less difficult, it is more desirable to determine the porosity, especially since this gives us an approximate gauge of the permeability of the material.

The pore space of a given volume of sand can be determined by the following formula:

$$\frac{Vd - W}{100\ Vd}$$

in which

V is volume of vessel in cubic centimeters,

d is specific gravity,

W is weight of the sand in grains.

The method employed for determining the porosity consists in filling a cylindrical vessel of known capacity with the medium whose pore space is to be determined and then computing the pore space from the weight of the material and its specific gravity.

The best results, according to King are obtained by allowing the sand to run into the receptacle in a fine steady stream. The closest packing and most uniform results being obtained by adding the material in small lots at a time, and gently tamping it with a broad flat faced pestle until the vessel was filled. After filling in this manner, the sides of the tube are gently jarred with light blows, until all reduction in volume ceases. In doing this it is necessary to hold the tube rigidly.

In the following table there is given the average fineness, specific gravity, and pore space in per cent. of the different Wisconsin and other sands tested, beginning with the brass sands and ending with the core sands.

		Average fineness	Specific gravity	Per cent pore space
53	Dye's special, Newport, Ky.	174	2.50	42.45
8	Zanesville, O.	163	2.72	44.70
9	Albany, N. Y.	143	2.62	44.41
10	Zanesville, O.	140		
43	No. 5, Newport, Ky.	140	2.60	40.11
52	No. 4, New Albany, Ind.	139	2.66	41.31
57	No. 1 molding sand, Hamilton Co.	130	2.59	42.66
55	No. 4, Waterford, Ind.	137	2.66	43.43
45	No. 3, Newport, Ky.	137	2.61	43.09
32	Racine, Wis.	136	2.65	44.14
27	Rockton, Ill.	134	2.56	42.09
44	No. 6, Newport, Ky.	132	2.64	43.26
54	No. 3, Waterford, Ind.	131	2.62	40.43
35	Pendleton property, Neenah	131	2.59	44.62
31	Rockton, Ill	129	2.67	43.58
17	Fairwater (Selected)	125		
34	Neenah, Brass sand	121	2.75	44.77
21	Altoona, near Eau Claire	119	2.67	46.83
51	St. Joe River, St. Joe Co., Mich.	110	2.59	46.45
19	No. 3, Berlin	106	2.57	42.38
36	Menomonie	106	2.63	44.95
7	Berlin	105		
49	No. 1, Indiana	105	2.59	45.18
28	No. 2, Berlia	103	2.60	39.4
24	Berlin	103	2.57	43.20
22	Garden City Sand Co.	93	2.59	40.60
47	Indiana No. 3	92	2.60	42.63
37	Marinette	92	2.50	39.18
26	Neenah	90	2.61	44.76
48	Indiana No. 2	88	2.62	38.00
29	Racine	86	2.60	37.66
23	LaCrosse	86	2.65	40.37
33	Racine	86	2.58	41.16
56	Wanatah sand, Valparaiso, Ind.	83	2.51	43.70
1	Berlin	83		
4	Pardeeville	82		
25	Janesville	78		
20	Wheatland near Burlington	76	2.51	47.26
6	Massillon, Ohio	74	2.58	42.76
15	Klondike, St. Charles Co., Mo.	73	2.59	34.98
3	Dover, Wis	72		
41	Janesville	70	2.73	32.91
11	Fairwater (selected)	68	2.61	32.00

12	Fairwater (run of bank).	66	2.63	33.90
50	Silverton, Kenosha Co., Wis.	63	2.55	39.52
42	Superior	63	2.61	32.50
65	Milwaukee, Wis.	63	2.61	32.50
35	Milwaukee, Wis.	62		
5	Pardeeville	62		
10	Pardeeville	62		
13	Core sand, Port Washington	62	2.62	36.23
46	South Milwaukee	54	2.61	38.83
58	Near Milwaukee, Wis.	53		
40	Kerrick, Minn.	49	2.65	33.91
2	Wheaton, Ill	41		
14	Ottawa, Ill	40	2.67	34.77
30	Janesville	40	2.58	40.41
39	Madison	39		

From this table we see that as the average fineness decreases, there is also in general a decrease in the porosity percentage.

Life of a sand.—Most molding sands after being used once lose some of their desirable qualities, and after one or more heats become "dead" as the foundryman calls it. The length of a sand's life is therefore a matter of some importance. Some sands can be used but once, while others can be used over several times, with or without the admixture of some fresh sand. The deadness of the sand is no doubt due to its dehydration by the heat of the molten metal, its plasticity or bonding power being at the same time destroyed, and the amount of sand thus destroyed in casting will be a layer of variable thickness next to the metal. With small castings this will be but a fraction of an inch, and it will of course be correspondingly greater with large ones.

Refractoriness—A molding sand should be sufficiently refractory to prevent its fusing completely when in contact with the molten metal. For this reason highly siliceous sands are the most desirable, at the same time a very high percentage of silica is only to be gained at the expense of alumina or clayey matter and a consequent loss in cohesiveness or bonding power. The effect of the chemical composition on the refractoriness of the sand is discussed under the chemical analysis of molding sands.

There is no standard laboratory test for determining the refractoriness of a molding sand. Perhaps the best would be to make a mold of the sand to be tested and pour into this an iron of known composition so that its effect on the sand could be determined. Means not being at hand to carry out this test, the next best plan seems to be to mold the sand into cubes and heat these rapidly in a furnace.

Table III contains the results of a number of tests of this sort made by C. W. Hord and kindly placed at the writer's disposal. The cubes were made by mixing the sand up with sufficient water to make the grains cohere, and then forcing the sand into a wooden mold by blows from a 9¾ lb. lead rammer, with a drop of four inches. These cubes were then heated in a gas furnace to a temperature of Cone 6 (fusion point approximately 2282°F., or 1250°C.), the time required for burning being from 45 minutes to 1 hour. After burning the cubes were weighed, soaked in water for 48 hours and weighed again, the increase in weight indicating the amount of water absorbed and being therefore an approximate index of the porosity after burning. Of course it will be easily seen that any shrinkage of the mass, or fusion of the particles will serve to close up the pores and decrease the absorption. Since it was recognized that the amount of tamping the sand received, and the quantity of water used might affect the density, four mixtures were made up as follows:

1. Water taken 6.6 per cent., number of blows, 3.
2. Water taken 6.6 per cent., number of blows, 9.
3. Water taken 13.2 per cent., number of blows, 3.
4. Water taken 13.2 per cent., number of blows, 9.

The results obtained given in Table III are not without interest. If we examine the figures given in the columns headed cube tests, we find that in every case, more pounding or a greater amount of water for mixing, tended to decrease the porosity as evidenced by the absorption figures, but that the use of a higher percentage of water, seemed to reduce the porosity more than an increased number

TABLE III

LOCALITY	GRADE	MECHANICAL ANALYSIS											CUBE TESTS							REMARKS
		Trade Number	Laboratory No.	20 Mesh %	40 Mesh %	60 Mesh %	80 Mesh %	100 Mesh %	100 Mesh %	Clay %	Fineness	% of whole	Number of blows 2 lb hammer 4 in. fall	Number of cc. water per lb of sand	Air shrinkage %	% Absorption	Fire shrinkage %	% Pore space		
Riverside, Pa.	Light iron		1	2.42	6.60	1.00	18.64	.92	50.11	19.02	88.1	98.71								Much trouble from blow holes. All right for fine iron castings.
	Brass		5	.74	5.06		7.60	.32	63.02	21.66	107.8	98.40								This sand caused blow holes.
Albany, N. Y.	Heavy castings . .		6	4.8	22.54	.22	33.74	.76	26.84	9.78	62.5	98.68								Good for general foundry and heavy castings.
Zanesville, Ohio . . .	Car wheel	4	4	1.32	11.18	33.40	4.29	6.64	9.84	32.82	67.3	99.49	3 9 3 9	30 30 60 60	0 1	23. 17. 13. 8.	5. 0.	35		Used for heavy malleables, cast iron pipe, heaviest ordinance, machinery castings, and air brakes.
Zanesville, Ohio . . .	Brass	1	3	.02	.45	2.02	.42	.86	80.36	15.06	125.9	99.19	3 9 3 9	30 30 45 45	0 0 0	30. 25. 25. 22.	1. 2. 1.	43		Fine, yellow, fine ornamental work, light iron, stove plate and brass castings.
Zanesville, Ohio . . .	Heavy and cupola	3	2	.19	.60	8.08	4.75	12.70	53.73	19.12		99.17	3 9 3 9	30 30 105 105	0 0	24. 20. 16. 11.	2. 2.5	37		Cubes burned red. Red sand used largely as No. 4. Also for lining ladles and cupolas.
Near Cincinnati, Ohio.	Very fine brass . .	0	7	.08	.12	.18	.10	.28	77.88	20.28		98.92	3 9 3 9	36 36 60 60	0 0	18. 12. 9. 7.	7.5 3.	45		Brass and light gray iron, mixed for stove plate.
Albany, N. Y.	Fine	1	8	.10	.14	.98	.12	1.18	64.94	30.76		98.22	3 9 3 9	30 30 60 60	0 0	2.8 1.7 .08 .02	10. 10. 7.5 10.	42		
Albany, N. Y.	Medium	2	9	.94	3.28	19.38	4.42	9.04	49.84	12.18		99.08	3 9 3 9	30 30 60 60	0 0 0 0	16. 15. 13. 8.	0. 0. 0. 0.	39		
Albany, N. Y.	Coarse	3	10	8.66	10.24	32.58	4.12	8.38	23.10	11.70	51.8	98.78	3 9 3 9	30 30 60 60	0 0 0 0	18. 12. 11. 5.	0. 5. 0. 0.	34		

Metuchen, N. J. . . .	Fine	11	3.44	12.40	25.84	6.60	19.12	24.50	7.28	59.	99.08	3 9 3 9	30 30 60 60	0 0 0 0	27. 24. 22. 8.	0. 0. 0. 0.	39	Much fine quartz and angular grains which clog meshes.				
Metuchen, N. J. . . .	Coarse	12	24.2	22.50	14.36	2.78	4.24	11.19	19.20	66.1	98.47	3 9 3 9	30 30 60 60	0 0 0 0	19. 16. 8.4 8.	0. 0. 0. 0.	33	Same as above.				
Metuchen, N. J. . . .	Medium	13	3.96	7.50	13.48	6.34	15.30	31.68	21.	79.5	99.26	3 9 3 9	30 30 60 60	0 0 0 0	31. 16. 9.	0. 0. 0.	39	Same as above.				
Florida Grove, N. J. .	Molasses sand . .	14	8.52	40.50	16.34	1.50	2.62	7.44	20.74		97.66	3 9 3 9	30 30 60 60	0 0 0 0	crumbled 22. 16. 13.	0. 0. 0.	40					
Florida Grove, N. J. .	Core sand	15	32.92	37.66	23.84	.44	.54	.80	3.76		99.96	Impossible to make into cubes					38	Very fine quartz and some mica.				

of blows, even though the former was only doubled while the latter was tripled.

One is somewhat puzzled to find the causes which govern the degree of porosity of the sand after burning. Taking the first absorption number of each set, we find that it ranges from 30 per cent. down to 2.8 per cent. This figure does not seem to stand in any direct relation to the average fineness or porosity of the green sand, neither does it appear to be directly related to the clay percentage.

It would seem that the porosity after burning is due to three causes, viz., amount of clay particles, an evenly proportioned number of the different sized grains, and the amount of fluxing impurities in the fine particles. That is to say, with a number of different sized particles there will be less porosity in the mass, than if most of the particles were of one size, because this enables them to flux together more readily because of closer packing.

Bonding Power or Tensile Strength—Sands used for molding should possess sufficient strength or bonding power to make the grains cohere, after the flask in which they are tamped is removed, and also for the purpose of resisting the pressure of the molten metal in the mold, or its corrosive action while being poured into the mold. Pure sand has little or no tensile strength, clay alone has a comparatively high strength, and the amount of bond will depend partly on the fineness of the sand, and partly on the amount of clayey matter in it. The tensile strength of the molding sand will be likewise somewhat affected by the amount of moisture in it, moist sand cohering more strongly than dry sand. The moisture content should not be in excess however, otherwise the sand will pack too dense. With clay the amount of coherence will not be seriously influenced by the amount of moisture, since the particles in drying shrink together, but with sand or even loamy sand when the shrinkage is exceedingly slight or even zero, there is no drawing together of the grains in drying, and therefore the presence of moisture aids the bonding power. Pressure may likewise increase it.

Where the mold is of complex design it is obvious that a stronger bond is necessary than for simple patterns. In such cases it may become necessary to increase the bond by the addition of some binding material, for a high bonding power in sand is to be obtained naturally only by the use of a very clayey material.

The chemical analysis of molding sands.—A difference of opinion appears to exist regarding the value of a chemical analysis of molding sands, and but few such analyses are on record. Those which have been published usually show a percentage of silica and consequently it has sometimes been assumed that all molding sands are highly siliceous. That this is not so in all cases is shown by the few analyses which were made for the Wisconsin work.

While the physical properties of molding sands are of pre-eminent importance, the chemical properties of the sand should not be neglected, especially since the chemical analysis may show the presence of objectionable elements, such as fluxing impurities, which are at times present in surprisingly large quantities.

Much the same interpretations can be made from a molding sand analysis as from that of a clay.

A high silica percentage indicates a large amount of quartz, while from the alumina and chemically combined water, we can make some estimate of the amount of clay present. The analysis will furthermore indicate the amount of fluxing impurities, such as iron, lime, magnesia and alkalies which the sand contains.

In most published analyses the percentage of the last four is very low, but in some of the Wisconsin sands the lime and even magnesia occur in appreciable quantities.

The allowable limits of the different ingredients, is not as a rule given.

Bolland* states regarding the chemical composition of molding sand that "3% of metallic oxides in sand seriously diminishes its refractory qualities and 1% of lime measureably lessens its value as a good molding sand, as the carbonate is acted upon by the intense heat and gives off CO_2 which disturbs the face of the mold during its escape causing honeycombed and rough surfaces on the casting. Caustic lime will cause a slag on the surface of the casting.

"Sands which contain the largest percentage of silica, from 1 to 3 per cent. magnesia, with as much alumina as will impart cohesiveness and plasticity are under almost all circumstances the best for facing sand. Lime should not be present in even the smallest proportions."

In specifications for molding sand, prepared by Mr. Scott of the Case Threshing Machine Co., Racine, Wis., the following statements are made regarding the chemical composition of sands for molds and cores.

Molding sand.—"Molding sand for iron work generally contains from 75.00 to 85.00 per cent. of silica, 5.00 to 13.00 per cent. of alumina, usually less than 2.50 per cent. of lime and magnesia, not over .75 per cent. of fixed alkali (soda and potash), generally less than 5.00 per cent. of iron oxide, and seldom more than 4.00 per cent. of combined water."

"Sand for brass molding may contain a much higher percentage of iron and lime without doing any particular harm."

"All molding sands usually contain some organic matter, generally present in the form of small roots or as decomposed vegetable matter."*

"Carbonate of lime must not exceed 1.50 per cent. in an iron molding sand, and should not exceed 2.25 per cent. in a brass sand.

"Iron oxide must not exceed 5.50 per cent. in the iron molding sand, or 7.00 per cent. in a brass sand."

"Organic matter must not exceed 1.00 per cent. Clay and silt are objectionable, consequently any sand showing an analysis more than 13.00 per cent. alumina is rejected."

Mr. Scott gives the following analyses of molding sands used for different grades of work.

*Encyclopædia of Foundry.

*The amount present is generally so small that it can be neglected.

	Light Iron Work	Medium Iron Work	Heavy Iron Work	Light Brass
Silica	82.21	85.85	88.40	78.86
Alumina	9.48	8.27	6.30	7.89
Iron oxide	4.25	2.32	2.00	5.45
Lime	....	.50	.78	.50
Lime carbonate	.68	.29	...	1.46
Magnesia	.32	.81	.50	1.18
Soda	.09	.10	...	.13
Potash	.05	.03	...	.09
Manganese	...	tr	.25	tr
Combined water	2.64	1.68	1.73	3.80
Organic matter	.28	.15	.04	.64
Specific gravity	2.652	2.654	2.63	2.64
Degree fineness	85.18	66.01	46.86	94.88

Mr. Scott states further, that "so far as chemical composition is concerned, any one of the above sands would answer fairly well for nearly any class of work, but it is absolutely necessary that the proper degree of fineness be considered.

Core sand.—"As a rule a core sand should be high in silica and low in alumina." A sand low in alumina will permit of the rapid escape of the gases whereas a high alumina or clay sand bakes and holds back the gases.

The two following analyses, although radically different, are good core sands, due entirely to low alumina and iron.

	Extra Quality Core Sand	Fair Quality Core Sand
Silica	94.30	69.31
Alumina	1.95	4.76
Iron oxide	.33	1.58
Lime carbonate	1.63	3.50
Lime sulphate	....	8.19
Magnesia	.54	7.77
Alkalies	.05	.12
Combined water	1.05	2.95
Organic matter	..15	1.82

"The effects of each of the elements commonly found in sands are as follows:

Silica is a refractory element, does not shrink when heated, and has little or no binding power, therefore in a highly siliceous sand the bond must be supplied either by the addition of clay, or some artificial compounds.

"Alumina is present in variable amounts in clayey or loamy sands, and aids indirectly therefore in bonding the sand. It is a refractory element of the sand, but has a high shrinkage and therefore too much alumina makes the mold bake dense.

"Lime is a fluxing element, and if present as carbonate, loses its carbonic acid and makes the mold more porous. The conversion of lime salts into oxide, causes the mold to drop or crumble if they are in excess.

"Iron, might be present in the form of ferrous oxide, ferric oxide, hydroxide, or ferrous carbonate, which may be converted into ferric oxide by heat, although it is probable that those portions nearest the mold are changed into ferrous oxide. It acts as a flux.

"Magnesia is probably like lime in its fluxing behavior towards fluxes.

"Organic matter may exert some bonding action on the sand, but in most sands there is but little present. It would burn out readily, and add to the porosity of the mold.

"Combined water will be present in any sand containing clay, limonite, or gypsum. It is driven off at a low red heat and thus increases the porosity of the sand.

The following analyses of molding sands have been collected from various sources.

	I	II	III	IV	V	VI	VII	VII
Silica	92.083	91.907	92.913	90.625	81.50	84.86	82.90	79.81
Alumina	5.415	5.683	5.850	6.667	9.88	7.03	8.21	10.00
Ferric oxide	2.498	2.177	1.249	2.708	3.14	2.18	2.90	4.44
Lime	tr	.415	tr	tr	1.04	.62	.62	.70
Magnesia	.....	.....	.....	.....	.65	.98	0.00	.88
Potash	.....	.....	.....	.....	....	....	....	....
Soda	.....	.....	.....	.....	....	....	....	....
Water	.....	.....	.....	.....	3.00	3.20	2.85	2.89
Org. matter	.....	.....	.....	.....	tr	tr	tr	tr

I. Sand from foundry of Freund at Charlottenburg.
II. Bronze sand, used at Paris.
III. Sand from Manchester.
IV. Sand from Lagua foundry at Stromberg.
Kampmann, Ann. des Mines, Sed. 4, Vol. VIII, p. 689. 1895.

V. Fine sand.
VI. Sand for medium weight castings.
VII. Coarse sand for heavy castings.
VIII. Sand for heavy machinery in dry sand molds.
W. Ferguson, Iron Age, Vol. LX, p. 16. 1897.

These analyses, it will be observed all show a high percentage of silica, since most of the sands used are of siliceous character. They do not however show the variations in composition existing in molding sands.

These are well brought out by a few analyses made for this paper.

	I (25)	II (27)	II (28)	IV (31)	V (34)	VI (36)	VII (42)	VIII (9)
Silica	88.52	79.41	90.68	57.63	44.24	88.35	87.47	79.61
Alumina	5.63	12.47	5.95	10.03	11.89	11.57	6.59	11.21
Ferric oxide	.88	.80	.48	.88	1.44	1.04	.80	2.48
Lime	1.20	.99	.69	11.16	13.71	1.33	1.18	.74
Magnesia	.83	.81	.44	5.63	5.90	.66	1.10	1.07
Ignition	2.65	3.96	1.95	14.66	18.49	2.45	.60	2.65
Alkalies	Not determined.							
Total	99.71	98.44	99.29	99.99	95.67	97.40	97.74	97.76

1. Core sand, Miltmore Quarry, Janesville, Wis.
2. Upper bed, Rockton, Ill.
3. No. 2 sand, White and Traugott Pit, Berlin, Wis.
4. Lower bed, Rockton, Ill.
5. Brass sand, Pendleton Pit, Neenah, Wis.
6. Sand from pit of Menomonie Hydraulic Pressed Brick Co., Menomonie, Wis.
7. Lake sand, Superior, Wis.
8. Fine sand, Albany, N. Y.

Two of these analyses, Nos. 4 and 5, show a very low silica content, and therefore show a correspondingly higher percentage of fluxing impurities, especially lime. Nos. 2 and 4, are of interest as showing the great difference in composition which may exist in different beds of the same bank. The others are mostly of siliceous character.

If the main use of a chemical analysis of a sand is to indicate the amount of fluxes and silica which the material contains, there is some doubt in the writer's mind, whether an analysis of the sand in bulk is what is needed. Such an expression of the composition does not show us in what condition the fluxes exist, that is to say, whether they occur in the coarsest or finest particles. If in the former their fluxing effect will be less active than if in the latter.

In most sands the fluxes are probably contained largely in the finer particles, especially if the deposits are of sedimentary character, for in these the coarse grains would represent the more destructible mineral grains, such as quartz.

If however the material is a residual sand that is by rock decay in situ, and some molding sands are, then the fluxes might exist wholly or in part in larger grains of partially decomposed silicate minerals.

In order to illustrate the uneven distribution of fluxing materials, a partial analysis was made of the several sizes of grains in a No. 2 sand from Berlin, Wis., with the following results.

Size.	60	80	100	100	Clay
Silica	95.92	94.35	94.66	91.06	61.54
Alumina	1.29	1.47	1.47	4.57	23.16
Ferric oxide	.56	.56	.40	.80	1.60
Lime	.10	.04	.34	.72	1.37
MgO & Alk. By diff.	2.13	3.58	3.13	2.85	4.33
Loss, ignition	undetermined				7.90
Total	97.87	96.42	96.87	97.15	95.57

Here we see that the finer particles are much less siliceous, more highly aluminous and carry a higher percentage of fluxes than the other sizes.

Mineralogical Composition — The mineralogical composition of the Wisconsin molding sands as well as that from a number of other localities is remarkably monotonous. A microscopic examination was made of all the different sizes obtained in the sieve tests, and in nearly all with the exception of the clay the predominating mineral was quartz. This sometimes formed 90 per cent. of all the grains in the sample. The grains are mostly rounded, and while those on the 20 and 40 mesh were often quite free from iron the smaller sizes often exhibited an abundant stain of limonite. Compound grains of quartz sand cemented by limonite were by no means

uncommon. In addition to quartz, feldspar, mica, and even garnet were sometimes noted. Several sands contained little sand tubes in the 20, 40, and even 60 mesh sizes. These were apparently cemented by calcium carbonate.

In a few, the grains retained on the 20 mesh were not simple minerals but small quartzite, gneiss, schist, and limestone. All of these were invariably angular. None of the sizes under 20 mesh could be said to be markedly angular although a few were subangular.

After examining this large number of samples under the microscope, one is forced to the conclusion that very little is to be gained from such an examination.

Mode of Occurrence of Molding Sands—Molding sands may be either of residential or sedimntary character. fragments of rock, such as sandstone, To the first class belong those sands formed by the disintegration of the rock in situ, while the second includes those formed by the decomposition of sandy or loamy material in water.

Residual sands may be derived from either crystalline or sedimentary rocks. If from the former their particles are likely to be angular; if from the latter the grains would tend to show a rounded form. No deposits of the first type of residuals are known in Wisconsin, although they might possibly exist, but examples of the secona type are not uncommon. The Potsdam sandstone of Wisconsin is in many localities so soft that it weathers easily to a mass of highly siliceous sand, which is composed almost entirely of rounded quartz grains. At many localities where the stone is exposed it is so soft that very little power would be required to disintegrate it completely if it is not already in that condition.

Sedimentary sands and loams are much more abundant, and form the main type of material obtained in the state. These sands represent sediments laid down by water in lakes, along the flood plains of rivers, or have been deposited by streams flowing from the margin of the ice sheet during the glacial period. Some of those found in the belt bordering the Great Lakes have been formed in the waters of these during a period when they covered a greater territory than they do now.

The coarseness of the material laid down will increase with the velocity of the current which deposited it, and variations in the velocity over any one area, will result in the accumulation of layers of different texture. Sand deposits not infrequently show both horizontal and vertical variation, and in the examination of a sand bank, care should be taken to ascertain whether there is a sufficient quantity of the desired grade present. Some deposits though otherwise good, are spoiled by the presence of clay lumps scattered through them.

In many areas, especially along the lakes, dune sands cover tracts of considerable extent. The materials forming these dunes are usually of little value, because they commonly lack even the small amount of clayey material necessary to bond the sand when moist.

In many districts three or four different grades of sands are obtained from separate pits all lying within a few rods of each other. Or again one bed may persist over a large area, with a thickness of not more than two feet, and underlaid by an equally persistent bed of totally different grade or texture.

Owing to the complexity of the glacial deposits in which most of the Wisconsin molding sands occur, it is difficult to lay down any rules that will guide the layman in his search for them. If, however, laboratory methods prove to be of practical value it becomes a comparatively easy matter to collect samples from all available localities and put them through a rapid preliminary examination.

THE INFLUENCE OF DIFFERENT ORE MIXTURES ON THE RESULTANT PIG IRON FROM THE STANDPOINT OF THE FOUNDRY.

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It would have been more in line with the subject matter of this paper to have made the heading read: "The Influence of the Chemical Constituents of Different Ore Mixtures on the Resultant Pig Iron,

From the Standpoint of the Foundry." Every foundryman knows, in a general way at least, the influence that the elements Silicon, Manganese, Sulphur and Phosphorus, exert on the pig iron and castings produced therefrom; that higher Silicon forces the Carbon out of combination with iron and causes it to assume the free or praphitic form, thus avoiding in a measure the hardness caused by the compounds of iron and Carbon, producing castings that may be more easily machined; that Manganese exerts the opposite effect, facilitating, while the iron is molten in the furnace, the absorption of Carbon, and increasing the quantity of Carbon which will combine with the iron, which may either be a strengthening influence within limits, or hardening influence, depending on the heat treatment the iron receives; that Phosphorus makes iron fluid and acts in the same manner, but in a less degree, as Silicon does toward Carbon; that Sulphur hardens iron and makes a casting less dependable, particularly sensitive to shock, and more likely to crack or check.

The writer is of the opinion that the influence ores exert on the pig iron made from them is due almost entirely to the percentages of Phosphorus, Sulphur and Manganese they contain and contribute to the pig iron made from them; that is, by changing the percentages of these elements in our ore mixtures we can, with other conditions all the same, produce pig iron having an entirely different character. There are of course other influences in pig iron manufacture that affect the quality, grain and uniformity of the product. It is necessary in order to have a uniform iron to have the furnace work smoothly. Slips of stock, scaffolding, stops of long duration, leaky water conditions, affect the quality and uniformity of the iron by reducing the temperature of the hearth of the furnace, thus lowering the Silicon and Manganese and raising the Sulphur and this, with the percentages of Silica, Phosphorus, Manganese and Sulphur in our charge remaining the same.

In order to better understand this we take charge of stock just as it is filled, and analyze its make-up:—

6,000 lbs. Coke.
12,000 lbs. Ore.
3,000 lbs. Limestone.

The above all contain, in varying proportions, compounds of Sulphur, Phosphorus, Manganese and Silicon, and with no disturbance in the furnace, the Manager can prophesy with reasonable certainty and closeness from analyses of this charge what the resultant pig iron will analyze, as he knows that, with a carefully burdened and normal working furnace, nearly all the Sulphur will go with the slag; that approximately 85% of the Manganese will be found in the pig, together with practically all the Phosphorus. The Silicon content will be governed entirely by the hearth temperature, rate of driving, proportion of fuel to total charge, temperature of blast and amount of moisture in the air, regardless of the amount of Silicon compounds in the charge. We are of course taking for granted that enough Silica exists in the charge to form with the lime, a good volume of slag to purify the iron by filtration and to allow the furnace to work free and keep the bosh walls clean.

It is not my intention to elaborate on furnace practice except to bring out as clearly as my ability and time permit, the fact that there is an influence exerted by the four influential elements on iron directly or through Carbon to the iron indirectly and that given the same furnace and foundry conditions this influence will be positive and uniform. So if we have an iron lacking fluidity we can remedy it by Phosphorus, tone up the life of the iron by additions of Silicon, add to its density and strength by Manganese, and avoid additions of Sulphur as far as possible, by means of carefully selected fuels.

I think much doubt has surrounded many foundry experiments because of the addition unintentionally of elements other than those desired. In other words there was a lack of knowledge of or consideration for all the ingredients charged to remedy a difficulty. For instance, the

iron has shown a sluggish tendency, or possibly an intricate casting suggests the use of high Phosphorus and Silicon, cold short (High-Phos.) pig is added without considering that there may be other ingredients exerting different influences contained in that pig iron, or possibly without due allowance for a weakened casting, for neither the Phosphorus or the Silicon add strength, both in fact have an opposite tendency. Or high-Silicon pig may be used to help out the machining cost at the expense of strength or wearing quality, due to lack of density of the casting owing to such addition, or in adding Manganese to get strength and density we may overstep the mark and get a hard, brittle casting, for Manganese exerts strengthening influence only within certain limits. The wise physician in selecting his treatment for the patient, uses as much care in eliminating those things exerting a bad influence as in choosing those remedies he believes will counteract the disease. Should not the foundryman follow his example?

I have endeavored by the foregoing to give my views of the reasons for some irons failing and some proving satisfactory. Now as to the subject outlined by the title of the paper. We must concede that no single iron can fill all the requirments arising in a foundry and make satisfactory castings for all purposes. It follows then that a selection of several irons must be made by the founder, and it is the writer's belief that it can only be made along analytical lines, disregarding grade by fracture entirely. The manufacture for pig iron today and the location of furnaces is determined largely by the matter of freight on raw material and pig iron. The margin above cost not admitting the producer to reach all markets, he must make the iron his trade demands.

The principal source of iron ore in this country today are: The Lake Superior region; the lower grade ores of the Appalachian Chain extending from Nova Scotia through New York, Pennsylvania, south into Virginia, Georgia and Alabama, forming in the latter three states vast areas of low grade ores; the magnetites of Pennsylvania, New Jersey and New York, together with the scattered areas of Limonites and Carbonates occuring in many states, and of more or less value depending on their richness and nearness to fuel and flux. Owing to the different percentages of the four influential ingredients, viz., Silicon, Sulphur, Phosphorus and Manganese, the irons from these ores have a different behavior in the foundry and have acquired reputations for performing satisfactorily certain desired results. This I believe is in no manner due to the locality or individuality of the plant where they are made. It is influenced in a measure by the fuel and flux, as by the use of, for instance, high Sulphur coke, when unless care is observed in handling the furnace, the resultant pig will contain more Sulphur than allowable. It is possible however with careful management to use high Sulphur coke if well burned and yet produce good iron. Many furnaces by nature of their location, being restricted to the use of certain ores, can only produce iron of certain analyses for Phosphorus and Manganese, these elements being regulated almost entirely by the amount of the same contained in the materials charged. Such an iron can be depended upon with more certainty if not analyzed than one having a wider range of ores to choose from. It is possible for a furnace so located to make a pig high or low in Silicon and with high or low Sulphur, for Silicon and Sulphur are subject to control, depending on proportions of fuel and flux in furnace charge. Furnaces located where they can draw their supply from the Lake Superior region, containing as it does ore suited to the manufacture of iron for all foundry purposes, should be able to fill any reasonable specification of the founder. The different ranges there:—The Marquette, Menoninee and Gogebic, known as the "old ranges," and the Mesabi of more recent discovery, contain the largest volume of the richest and best working ores, for all purposes, insuring a certain supply for the next forty or fifty years with allowance for increase in consumptive capacity. To this, as a possible source, can be added the leaner higher-Phosphorus ores

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of Minnesota and Wisconsin, just now being prospcted, the extent of which is not at present known. They extend over large areas and doubtless aggregate large tonnages. There are moreover being shown up by the industrious prospector evidences of other districts in Northern Minnesota and Canada, which will be tributary to the Lake region for shipment, and available as supply for furnaces using Lake ores.

The above ores, classed as "Lake ores," are almost entirely hematites, with some magnetites and limonites. In Wisconsin are found some fossiliferous ores. Most Lake Superior ores are low in Phosphorus, more than half the tonnage going into Bessemer iron. The Menominee and Marquette Ranges supply the bulk of the ores high enough in Phosphorus to produce neutral foundry iron. These, used in connection with the more chiefly mined ores from the Mesabi Range, produce most of the foundry irons made from Lake Superior ores.

Lake Superior hematites work smoothly in the furnaces. Some little trouble was experienced working the finely divided ores from the Mesabi Range when they were first used, but practice has been adjusted to these ores, and no difficulty aside from dust losses is now encountered. The deposits on this range are the largest in the world now opened, and there will be shipped from this range before it is exhausted over one billion tons of ore. Nowhere has Nature been kinder to the metallurgist than to the producers of iron in that region where Lake Superior ores are smelted with Connellsville coke.

The pig irons made from certain kinds of ore, such as Carbonates, Limonites or Magnetites, have at different times been supposed to possess particular merit, or to accomplish certain desired results in the foundry. The writer believes the happy blending of certain chemical elements is responsible for this. We do know that certain ores work well in the furnace—that is, absorb Carbon and the reducing gases in the furnace readily, due to their porosity or to the expulsion of carbonic acid and water, thereby decrepitating and affording channels for the reducing gases to penetrate, thus being reduced to iron throughout the mass. This being true we should expect the porous hematites, the carbonates and limonites, to work the best. This is the case, and irons with especially good reputations are made from them. Magnetites, specular hematites and dense hard hematites must proceed through the furnace more slowly, and attempts to drive them too fast result in bad working of the furnace. Magnetites are particularly hard to reduce, due largely to their density, admitting of superficial reduction only. Mill or puddle furnace cinder reduces in this manner in a more marked degree, and has a melting point so low that frequently causes bad or irregular working by melting before entirely reduced. Mill cinder is moreover usually irregular in composition, and in general tends to irregularity in chemical composition of iron made from it. We think therefore the existing preudice against cinder iron has some justification.

While we believe chemistry will explain the failures and disappointments encountered in the foundry, it can only do so with the co-operation of the intelligent founder—the man whose judgment guides the operation of the cupola, and directs methods and manner of pouring and molding, who selects as carefully his other materials as he does his pig iron. It has always seemed to the writer extravagant to the point of folly to pay high prices for charcoal iron and melt it with coke, and poorly selected coke at times. Would it not be more reasonable to use an ordinary iron and re-melt with charcoal to get the same result, or remelt charcoal iron with charcoal if very low Sulphur is necessary in the casting. Pig iron made with charcoal is preferable for some purposes to the coke product, for the reason that in general lower Silicon iron can be produced with charcoal, without having high Sulphur, thus getting an iron that will chill but not be weak.

The balance maintained by the Silicon, Sulphur, Phosphorus and Manganese is of vastly more importance than the exact percentage of any single element. The

XUM

total Carbon in foundry iron does not vary greatly, different pigs from the same cast are likely to vary as much as pigs from entirely different furnace plants. An experienced chemist, given Silicon, Sulphur, Phosphorus and Manganese, can estimate the combined and Graphitic Carbon close enough for foundry purposes.

It is well known that certain brands of iron have deservedly good reputations in the foundry, when other brands, occasional samplings of which show approximately the same analyses, fail. I am of the opinion that this good reputation is acquired by care in the operation of the furnace-keeping uniform the blast pressure, temperature and furnace burden, thereby insuring uniform iron, using care in piling and selecting iron according to analyses, shipping iron according to specifications, and keeping in touch with the consumer to learn his needs. While the chemical influence of the elements Silicon, Sulphur, Phosphorus and Manganese is always fixed, there must of necessity be uniformity of analyses within reasonable limits, in irons having the same name or grade, if good results are to be expected, hence the necessity for analyzing each cast and keeping intelligent record of same, and of marking and numbering the casts where piled. After an experience of 20 years as furnace chemist and superintendent, I am positive that grading iron by fracture is a very dangerous and costly practice for the founder. I can readily see why the furnaceman should prefer it. Combination grading by fracture and by analysis is not fair to the furnaceman. I have frequently seen specifications of this kind so conflicting as to render the proper and honest filling of the order impossible. We never hear of fracture in the steel-making iron trade, the influence of the chemical elements is taken as an axiom. Neither is there any attention paid to the ores or other materials from which the iron is made, simply the hard and fast rule that certain chemical specifications must be adhered to.

To sum up the matter outlined by the title. Given an ore mixture of proper chemical composition for making satisfactory iron, no further benefit can be transmitted to the iron by the ore than that which comes through regular uniform working of the furnace. Judging iron by that mysterious ingredient variously denominated as character, body, physical properties, etc., and which is supposed to find expression in the color and grain of the pig, bears about the same relation to intelligent foundry practice as the Indian medicine man does to the educated physician. We have the best ores, fuels and fluxes of any nation on earth, let the founder and furnaceman join hands, dismiss prejudice and superstition and attack the proposition along scientific lines, and together work out the destiny nature has shaped for them.

MULTIPLE MOLDS.

BY JAS. F. WEBB, ELKHART, IND.

The first cost of rigging up for the multiple mold is not a great deal. You can use the same patterns that are used in a snap flask, the only change to be made is to put on two pins on the pattern board to the fit pin holes in the flask; and to put on an upright gate to connect the molds. It is good policy to have the upright gate ¼" shorter than the depth of the flask, and to cut through with the sprue cutter after drawing the pattern; if it is full length it interferes with the presser head. The next thing is to make a set of iron flasks. This is for molding machine practice. It is best to use iron flasks here as there is less chance for discount.

In railroad shops there is a wide range of work that can be made in the multiple mold. Fig. No. 5 shows some of our patterns rigged for multiple molds, all plain on top. In molding a 12"x 16" snap flask, 4" cope, 3" drag, there are 1344 cu. in. sand used to ram it up. In a 12"x16" multiple mold 3" deep there are 576 cu. in. of sand, showing a saving of over 57% of sand to handle which is no small item in the course of a day, both in preparing it in the morning and handling it in the molds. Besides this there is the saving of floor space.

Twenty-four snap flasks 12"x16" require

FIG. 1

FIG. 2

FIG. 3

FIG. 4

a space of 32 sq. ft. to place them on the floor. Two multiple molds twelve high require a space of 4 sq. ft., allowing 4" between handles on the flask to operate them, which gives plenty of room for this purpose. This represents a saving of floor space of 87½%. When business is good and room limited this is quite important.

Fig. No. 2 shows the comparative saving in floor space. Furthermore it illustrates how a great deal of hard work in pouring off is done away with. Snap flasks are commonly poured with a hand ladle of about 45 lbs. capacity. Multiple molds may be poured with a larger ladle, sav 200 lbs. capacity. An overhead trolley is a handy thing to have in pouring off.

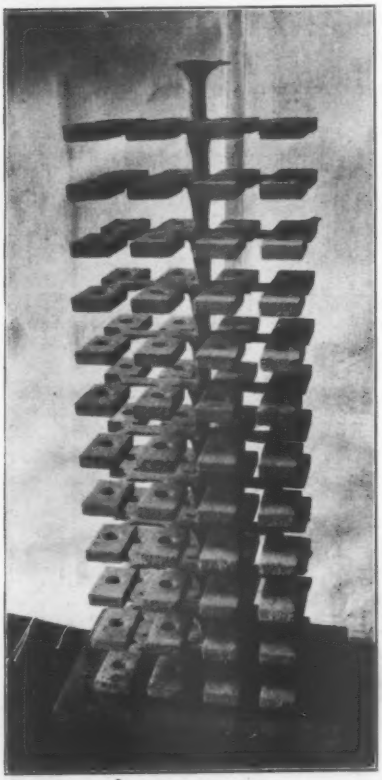


FIG. 5

Twenty-four snap molds that weigh 15 lbs. each mean 8 hand ladles for the molder to carry, and the same number in multiple molds means 2 ladles of 180 lbs. capacity to pour which makes it a great deal easier. (See Fig. No. 2 and 4) and the discount is not a great as in a snap flask, the loss being about 1%.

More patterns can be used in a flask, for they can come closer to the edge of the mold without danger of running out. See cut Fig. 5 as to quality of castings. We have patterns, where in a snap flask, twelve were as many as could be put in one mold, while in a multiple mold we now have eighteen, an increase of 50% output to each flask.

When making a multiple mold, the iron flasks must be arranged with a rib extending in about ¼" on the inside to hold the sand in the flask. When closing it down place the flash on the pattern board with the rib up, so that after it is rolled over it will be on the bottom. Have an iron frame to fit the top of the flask ¾" deep; riddle sand on your pattern and fill the flask flush with top of the iron frame. Put the presser head on and press your mold. Then take the frame off, strike off the sand even with the top of the flask, throw a little loose sand on top and rub down with a finish board, roll over, draw the pattern board and cut the gate, and place the mold on top as Fig. 2 shows. In making the bottom part of the mold use a regular bottom board and stop off the upright gate even with the other gate.

We are using the Farwell Molding machine to advantage in making multiple molds, and as it is not a high priced machine it will not cost much to try it out. One of them is shown in Fig. 1 with some of the patterns we are using in the multiple mold in connection with patterns we have on boards. We are using a brass frame on the outside of the board fastened at the corners.

The vibrator, which does away with all rapping by hand, we secured from E. H. Mumford & Co., who had just what we wanted and only cost $10.00. I don't know how we could get along without them, frame and vibrator attached being shown in cut Fig. 1 on the machine with

XUM

knee valve fastened to lift the table at the right hand side.

In making these molds the gates leading to the casting want to be small enough to allow the iron to congeal and get set so as not to cause any undue strain or pressure. The metal in bottom mold gates want to set before the part above is filled. In making these molds it must be remembered that there are no bars in the flask, as they would interfere with shaking out. There should be enough sand under the pattern to keep it (the sand) from falling out. With a flask 3" deep we are making six castings in a flask 1" thick without any trouble, This allows 2" of sand under the pattern.

One further advantage is that the molder can continue to mold after the blast is on, for he knows he can pour off in a short time, and that he will not have a lot of hand ladles to carry. I feel certain that any railroad shop can use this way of molding to good advantage, not to mention any other line of work.

ELECTRICITY IN THE FOUNDRY.

BY F. L. ANTISELL, PORT AMBOY, N. Y.

That the use of electricity as applied to the arts and sciences is practically unlimited, is being proved more and more every day, and if its use in metallurgical processes were more familiar to the foundryman, he would command an agent that would lend valuable aid in numerous instances. Speaking broadly of the subject, a field that from present indications, promises such a great future, should certainly receive some attention from the foundryman, with a view of applying it to his everyday foundry practice.

In one department of electro-metallurgy, namely, the electro-deposition of copper, we find useful assistance in some instances for the foundryman and a means by which we may explore this field to a limited extent in a profitable manner.

The hydro-electro-metallurgy of copper is an industry of great importance. It is most familiar to us in the refining of the metal, and in electrotyping. The latter art gives us, in almost any book of fine print, an example of perfection in molding and casting, when it is remembered that from a page of type that forms the pattern, a mold of wax is made upon which is deposited a shell of copper, or electrotype, from which the page of type is struck.

The making of electro-bronzes, statuary art work, and the protection of iron from the elements, furnish other instances of the useful application of electro-deposition.

Certain varieties of duplicate patterns may be constructed cheaply and true to drawings. Artistic patterns may be produced in a most satisfactory manner with perfect drawing finish, light and durable. Wooden patterns (when it will pay) can be covered with a veneer of copper, giving a perfect surface and the advantages of a metal pattern, with about the weight of wood and costing but little more. Match boards can be made to almost any size that will make a perfect parting for the most intricate castings.

For a complete description of electro-deposition, the reader is referred to any of the standard books on the subject. Several good descriptions of electro-metallurgical processes may be found in the various encyclopedias. For the benefit of those who are not acquainted with the subject, a short description of the process as applied to foundry work will be sufficient.

Figure 1 shows a tank of suitable size for the work in hand. The experience that most foundrymen have gained in the construction of picking vats may well be put in practice here and a vat be constructed on the same general lines, lining it with about eight pound lead and burning the joints Where a finished tank cannot be procured at a reasonable price, or the services of a competent lead burner to make the joints, a single sheet of lead may be folded in such a manner as to

lap over the ends of the inside lining of the tank with which the lead should be protected, thus forming a lining without any joints whatever. The wood work should be coated with a suitable paint and the tank bolted to keep the sides from bulging.

The tank should be filled to within a few inches of the top with a solution composed of copper sulphate and sulphuric acid (about two pounds of the copper sulphate to a gallon of water) the hydrometer indicating 15 or 16 degrees Beaumè. Commercial sulphuric acid should then be added to bring the reading up to 18 or 19 degrees Beaumè. Suspended to the rod which is connected to the positive pole of a dynamo, battery, or other source

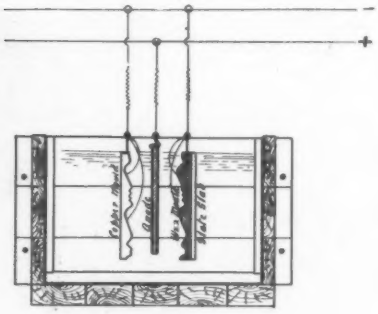


Fig 1

of electric current at the proper voltage is a plate of copper, preferably electrolytically refined copper that has not been melted subsequent to the electro-refining process, this plate forming the anode. Suspended to another rod, which is connected to the negative pole of the same source of current, is the mold or pattern upon which we desire to deposit a coat of copper. In this instance we will assume that we wish several patterns of an artistic design and where the draft is reduced to a minimum. Modelled upon a plate of slate, or even wood, is the pattern we wish to duplicate in copper. The surface of the pattern may be made a conductor of electricity by dusting on it by means of a soft brush a mixture of graphite with a white composition bronze and connecting this prepared surface with the negative conducting rod by means of a number of small copper wires. Upon the introduction of the mold thus prepared in the electrolyte a thin film of copper will be immediately deposited upon the surface of the mold by reason of the atomic displacement of the tin for copper, upon which surface the copper will continue to build a deposit or shell at the rate of about 0.0025 pounds per ampere hour. The usual rate of current for this work is about 10 amperes per square foot, at about one volt. By circulation or agitation of the electrolyte, the current can be increased to 50 or 60 amperes per square foot, but only at the expenditure of a larger amount of power.

When the mold has attained a thickness of copper that will weigh about 20 ounces to the square foot, it may be removed from the vat and stripped from the wax mold which must necessarily be destroyed. The back of the shell is then to be coated with an insulating paint or varnish, the inside of the shell to be cleaned and oiled with a mixture of grease and graphite. By making proper connections and suspending the shell or mold, as it may be called, again in the tank, and plating copper to the desired thickness upon its surface, we produce a perfect copy of our wax pattern. This shell may now be stripped from the mold, and braced by soldering strips of copper to its back and backing it in a suitable manner.

A pattern constructed in this manner has certain refinement that we of course cannot expect to duplicate in the iron casting. It is, however, one step in the direction towards producing castings with sharply defined surfaces.

Another application of this process is in the making of match boards. Var-

ious methods will present themselves to the experimenter when he is more familiar with galvanoplasty (as this process is termed).

Owing to several successful methods of making small matches of various compositions, the copper match will be found most useful for large sizes of patterns. In making a match for a metal pattern, the pattern is waxed and imbedded in wax. A parting is then made practically in the same manner as if we were going to make a sand match. The pattern and face of the parting is made a conductor of electricity, proper connections made and the entire pattern placed in the depositing tank.

The thickness of the shell will depend upon the size of the pattern; 24 ounces per square foot will be found to be about right for the ordinary match four feet square. When the shell has attained a sufficient thickness, it is taken from the bath and the back of the shell is re-inforced by soldering on it strips of copper, filling with plaster of Paris and finishing off with wooden backing.

Numerous opportunities present themselves to the electro-metallurgist for applying this particular art to foundry work.

It is needless to mention that this process requires great attention to details, such as, maintaining proper voltage and current density, suitable amounts of copper in free acid solution, proper temperatures, and possibly circulation or agitation of the electrolyte.

The art has been carried to perfection by makers of electro-bronzes, so far as the deposition of copper is concerned. Could we deposit iron with the same facility that we can copper, there would certainly be a new and great change in foundry methods, and it is quite possible that in the future, iron and alloys will be deposited as successfully as copper is at the present time.

FLUXES IN THE CUPOLA.

BY N. W. SHED, BUFFALO, N. Y.

The value of fluxes in the cupola is not generally appreciated by foundrymen. Hundreds of cupolas are not slagged at all and the cinder dumps show an immense amount of iron actually wasted.

Not only is iron lost by the large amount combined with the cinder but the more or less infusible cinder encloses small masses and shots of iron which cannot be separated. It is a fact that the cinder dumps of many foundries contain more iron than many workable deposits of iron ore and if these accumulations could be gotten by the German blast furnaces they would be quickly utilized.

Another value of fluxes is their cleansing action on the cupola. A well slagged cupola has no hanging masses of iron and cinder which require laborious chipping out. The time and labor saved in consequence is an item that is well worth considering. In the running of heavy tonnage from a single cupola fluxes are indispensable. It would be well nigh impossible to run large heats in the same cupolas without using a good flux.

The value of fluxes being generally admitted the question arises, what flux is best to use, and how much?

There are two available fluxes for the cupola, these are limestone and fluorspar. Fluorspar is much advertised as a flux and the promoters claim that it gives marvellous properties to the iron. The glowing advertisements have evidently deceived the U. S. Geological Survey, for the reports of the survey speak of its great use and value in foundry practice.

The practical tests of fluorspar made by the writer showed it to be an inferior flux, it did not remove sulphur and the properties of the iron were not improved in the least by its use.

There is no doubt of the value of fluorspar in certain branches of metallurgy but the writer has failed to find

a single supporter of its value in the foundry.

Limestone is far cheaper than fluorspar and far better as a flux. It makes little difference what form the limestone has so long as it is pure. It may be marble, soft limestone, hard limestone, oyster shells or mussel shells but it must be good. A limestone containing over three per cent of silica is poor stuff and one containing any considerable amount of clay should be rejected.

There should be at least 51 per cent of lime present. The sulphur should be below one per cent to two per cent. The phosphorus is not important. A magnesian limestone would do as well as ordinary limestone for the cupola. The amount of limestone to be used is variable, depending first, on the amount of silica in the coke ash. Second, on the amount of silica or sand adhering to the pig or scrap. And third, on the amount of silica to be carried by the slag.

The amount of limestone required to flux the coke ash can be figured according to the ordinary method of calculating blast furnace charges. The amount of sand on the pig and scrap is so variable that it is difficult to know just the additional amount of limestone to add.

The most practical slag and easily fusible slag has been found to be a monosilicate which means having equal amounts of silica and alkaline bases. Having these three variables in mind we find it a good rule to figure the limestone on the weight of the coke, using 25 per cent limestone. For example, if the charge of coke on the bed is 4,000 lbs., we use 1,000 lbs. of limestone. The next charge of coke is 1,000 lbs., we would use 250 lbs. of limestone. This amount of limestone will flux any ordinary coke ash with the average amount of sand on pig and scrap. If we know the amount of sand on the pig to be excessive we figure 30 per cent limestone on the weight of the coke.

With a low coke ash, machine pig and clean scrap the limestone may be reduced to 20 per cent and make a good cinder.

Many foundrymen are afraid to use limestone, fearing some injury to the iron. This is a superstition for the lime has no effect on the iron. There is usually a slight reduction in the amount of sulphur but owing to the great amount of iron present the iron absorbs a large amount of sulphur from the coke.

If more than 30 per cent is required to make a good cinder and clear the cupola it is evident that either the coke is very high in ash, or else the limestone is high in silica. In the latter case a large amount of lime is used in fluxing its own silica.

On account of the frequent variations in the stock it is a good plan to have coke, limestone and cinder analyzed occasionally. The cinder usually tells about the condition of the furnace. A light brown indicates a small amount of iron and the iron unoxidized. A black cinder usually indicates a large amount of iron and some oxidation. A shiny metallic lustre shows an excess of oxide of iron due to over blowing or lack of coke. Practically all the lime cinders from a cupola are glossy in appearance while the cinders with no lime are usually dull and earthy.

Occasionally a cinder is found full of bubbles, the color is usually black and shots of iron are found through the frothy slag. This is called foaming cinder and is made when the last few charges are at the bottom of the cupola. This cinder often rises to the charging door and flows out over the floor. The iron cast at this time is hard and is low in manganese, silicon and carbon. With the foaming slag a dense smoke of reddish brown color pours out of the stack.

Analysis of this foaming slag shows the iron to be in an oidized condition and in large amount. Sometimes the iron will run to 30 per cent in a frothy

cinder, sometimes only to 12 per cent. The oxidized cinder and the red smoke show that iron is being rapidly burned in the cupola and the action going on is very much like the action in a Bessemer converter when it is tilted a little and blown to gain heat by burning the iron. The cinder is oxidized and the red smoke is produced in the same way. In both cases the iron is burnt to oxide which is quickly taken by the slag. The oxygen in the slag acts upon the carbon of the iron forming a large amount of carbonic oxide which rises through the cinder blowing it to a frothy condition.

There are two ways of avoiding this troublesome condition. If possible reduce the blast. If blast cannot be reduced add more coke. The presence of a good body of coke will stop the burning of the iron and the frothing does not take place.

In some cases the loss of silicon is very serious and to insure good castings it is necessary to add crushed silicon metal and ferro-manganese to the stream of iron as it runs from the spout.

Analyses of cupola slags where no flux is used show from 14 to 28 per cent. These slags contain two per cent to four per cent of shot iron mingled with the cinder. This proves that some of the iron must be lost in order to flux the coke ash and sand.

If we need limestone as a flux the amount of iron in the cinder is rarely over three per cent showing that the lime fluxes the ash and sand leaving the iron for the ladle. And the question is simply whether we will use iron as a flux at $18 per ton or limestone at $1.50 per ton? Another point in favor of the limestone is the clean cupola mentioned in the first part of this paper.

Following will be found an analysis of cupola cinder using lime compared with an analysis of cinder without lime. Using lime without lime.

Ca o	34.60	Ca o	6.60
Fe o	4.10	Fe o	21.76
$Al_2 O_3$	11.02	$Al_2 O_3$	11.80
$Si\ O_2$	48.20	$Si\ O_2$	58.44
Mn o	1.40	Mn o	1.30
S	.20	S	.10
	99.52		100.00

MODERN PIPE FOUNDING.

BY H. A. CROXTON, MASSILLON, O.

Pipe founding as practiced in this country at the present time, while showing a decided improvement over methods pursued in the past, strange to say does not differ materially from the old fashioned way of making pipe.

There is no branch of the foundry business that is so dependent on tonnage for profits as the manufacture of cast iron pipe. Within ten years the required amount of tonnage which it is necessary to produce daily to enable the manufacturer to compete on a satisfactory basis, has changed from 100 tons per day to 200 tons per day.

The subject of cast iron pipe founding has received but meager attention in our technical and trade papers, and the principal reason for this is the fact that the majority of pipe founders are exceedingly careful as to what information they give out. This policy we believe to be narrow and a careful investigation of the great progress which has resulted in the different lines of iron and steel manufacture in the United States, shows that the greatest results have been produced by those manufacturers who have been willing to exchange views with their competitors. It is not the writer's intention to go into a lengthy treatise on the subject of pipe founding, but it is rather my intention to treat the subject in the light that will most interest the American Foundrymen's Association members.

Probably the most important item to be considered in the cast iron pipe business today is the general outline of the proposed plant. My remarks to you will be based on a pipe foundry with a daily capacity of 200 tons of finished product, or more properly

speaking, a yearly capacity of sixty thousand tons. The plant should be located on not less than 40 acres of ground with buildings centrally situated. The modern pipe foundry handles in and out of the plant five to six hundred tons of material every day and the handling of such a vast amount of material must be done at the least possible cost, and for that reason starting with the pig iron yard, which should be on a level with the cupola deck, the plant should be laid out on a one per cent grade line down to the finished product track which should be depressed. When you stop to consider that a modern pipe foundry produces and finishes complete a piece of pipe for every forty seconds in the day, you will have a good idea of the nicety with which each department must do its work.

The pig iron mixture required in making pipe is one of that does not always receive the attention which it deserves. The writer was one of the first pipe makers in the United States to establish a complete laboratory and it has been our experience that iron mixed by a chemical analysis without paying any attention to fracture will produce better and surer results than any of the old fashioned methods with which the writer is familiar. To obtain first class results we aim to use not less than four different brands of iron in our mixtures, which nearly eliminates the evil effects which might arise from any one brand running irregular in its analysis. Each car of iron is analyzed, before using and handled accordingly. The coke is also analyzed, particular attention being paid to sulphur and ash.

Men connected with the pipe foundry business have always been early risers. The majority of pipe foundries in the United States start operations five o'clock in the morning and in about an hour afterwards, are ready to pour, which operation continues without interruption until about two o'clock in the afternoon.

The flasks in which the pipe are cast are made of cast iron approximately 13 feet long with eyes in center; these eyes are so placed that the flask is in good balance. After each pipe has been cast, by the use of an overhead traveling crane these flasks are taken out of the pit and opened up over a pair of skids thus permitting the sand to drop into a shallow pit provided for this purpose while the pipe are rolled out of the main building. All of the flasks are rammed up on the preceding day to casting; the molds are dried over night and should be dried thoroughly as skin dried molds are very liable to cause trouble, especially after standing in the pit for several hours before being cast.

In our foundry we make three pieces each of three, four and six-inch pipe in a flask; two pieces each of 8, 10, 12 and 14-inch pipe in one flask; 16 inches to 72 inches inclusive are cast singly. The cores are made in a "strike" and on sizes up to 12 inches the bar is made of wrought iron pipe; on sizes above 12 inches the core bars are made of cast iron. On sizes three, four and six-inch pipe, loose hay is wound on the core bar until it is thoroughly covered after which the first coat is put on, ranging about ¾ inch in thickness, this varying with the different sizes of pipe to be made. After the first coat is put on, the bars are loaded on a car with an electric traveling crane and then dried in ovens conveniently arranged to receive the cars. About 11 o'clock in the morning the bars are taken out of the ovens and put in the finishing "strike" and the second coat is put on; before the bars are moved from the "strike" the cores are covered with blacking and they are then replaced in the ovens to dry over night. To insure a perfect pipe it is necessary that the cores should be placed the following morning in exact central position in the molds. To do this we use tapered socket on the chill plate and the same taper is made on the core. At top of flask we use

a slip socket core which drops into the tapered mold at top and as it has a centrally located opening, it insures the top of core being held in exact central position.

After the pipe have been cast they are allowed to cool for about one-half hour after which they are taken out of the flasks and permitted to roll out of building to the cleaning department. About half of the material which is taken out of the pipe in the shape of burned core is taken back to the mud mills and ground over; the balance going to the dump. With proper care and skilled workmen, there is very little to do in the way of chipping. The gates must be knocked off and any imperfections which show must be removed; for this purpose we have tried compressed air but it has been our experience that a good chipper with chisel and hammer can clean more pipe than the most expert man with a pneumatic hammer. After the pipe are properly cleaned, they are run into an oven, which is built on the runway, and operated with counter-balanced doors. This oven is long enough to permit a 72-inch pipe to make one complete revolution in going through same. In making this revolution the pipe has been heated sufficiently to permit of dipping it in tar, and after the dipping process which is done by means of an electric elevator, the pipe are rolled out on skids. In about ten minutes they are cooled sufficiently to make the tar set, giving it a coating which will forever preserve it after being laid underground. After the dipping or coating process, each individual pipe is weighed on a pair of scales built in the line of runway, and each pipe is then tested hydrostatically to 350 pounds per square inch.

The specifications and requirements of the largest users of cast iron pipe have become so rigid during the past few years, that while they require a test of 300 pounds per square inch, it has been our practice to test from 350 to 400 pounds. If the pipe breaks here at the mill, it is simply a matter of remelting the scrap, while if it breaks in the trench, it causes all sorts of trouble and usually quite an expense account. There is a moral obligation which makes it necessary for all pipe men to replace any defective material, and while in a great many cases the cause is one for which the pipe men should not be blamed, at the same time there is very little to do other than settle the contractors' bill for damages.

After the testing of pipe, the pipe are rolled into cars on the depressed track to receive it; if not they are handled by the locomotive crane and skidded on the yard for future orders.

Of the mechanical arrangement of a pipe shop, the three-motor traveling crane is the most important. The cranes which we are using are of our own design and are built especially for pipe work. One crane is required to each pit where the square pit is used and two cranes are required if the circular pit is used. The square pit has decided advantages over the circular pit for the reason that a straight line is the shortest distance between two points. On the square pit the hook of the traveling crane can drop in approximately a straight line from any point to a desired point in the pit; with the jib crane, this is impossible. The crane runners must be more skilled than in any other line of manufacture with which the writer is acquainted. We have tried crane runners who have come from the largest eastern steel mills with the best of recommendations, and have found that they are unable to operate pipe shop cranes satisfactorily.

Probably the most important feature in the operation of a cast iron pipe foundry today is the pipe founder's ability to establish a first class organization, including all the skilled workmen required and then he must be able to run his plant to its utmost capacity every working day in

the year. There is a heavy overhead charge in the making of cast iron pipe which amounts to about $2.00 per ton. A full capacity permits the absorption of this overhead charge on a satisfactory basis, while a small capacity in competitive times would make the cost of production so high that the material could not be sold on a competitive basis.

The refuse from a cast iron pipe foundry is also a matter that requires serious consideration. In our plant we have about eighty tons of refuse per day to take care of and unless the shop is properly arranged and some provision made to dispose of this refuse, it means an additional item of expense.

The wear and tear, or more properly speaking, depreciation of a pipe foundry, is extremely heavy, and I know of no line of business that more properly illustrates this than to compare it with a blast furnace. It is our policy to write off 50 cents per ton from the plant each year as depreciation and in addition to that we allow 50 cents per ton for repairs. While this may appear excessive to some of you, it has been our experience that it about covers the exact facts.

Foundrymen's Assoc.

AMERICAN SOCIETY,
SEP 30 1906
OF CIVIL ENGINEERS,
NEW YORK.

American Foundrymen's Association, Eleventh Annual Convention, Cleveland, June 6 to 7.

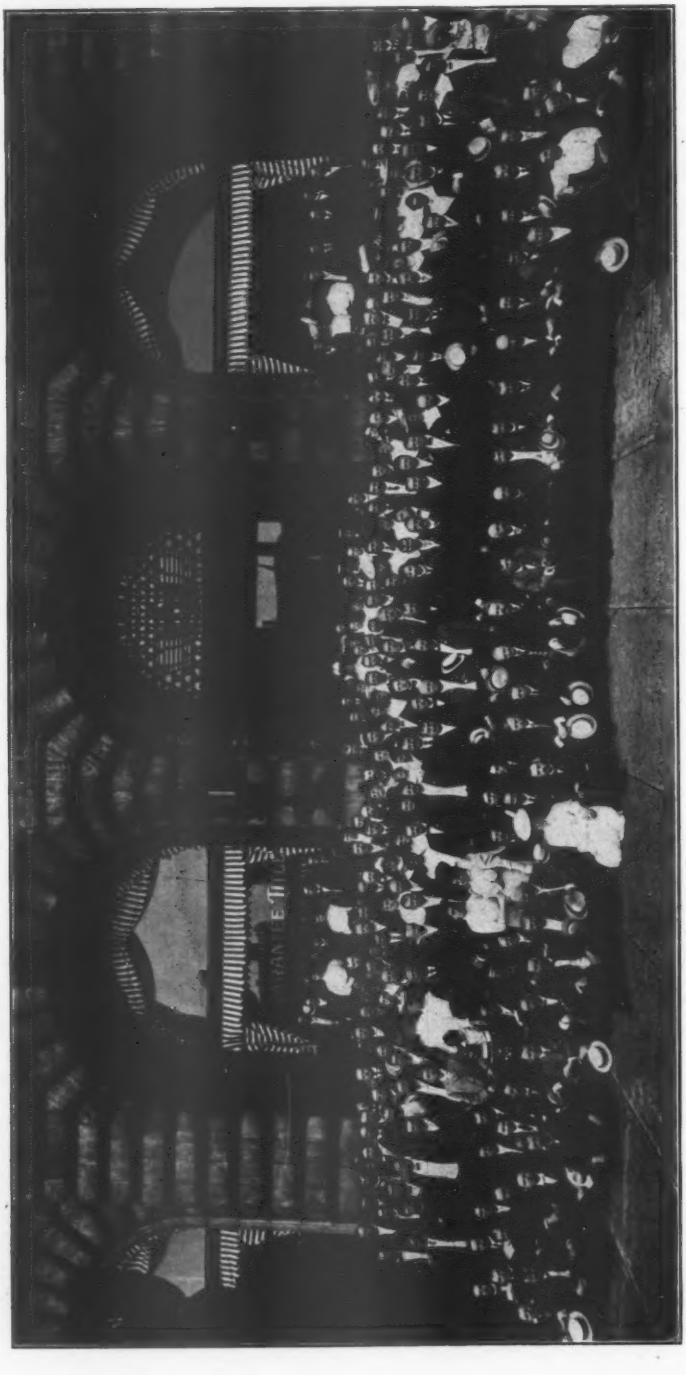
THE eleventh annual convention of the American Foundrymen's Association was marked with many features which are new and which show not only the past work of the association, but its growth and opportunities for future development. In the matter of papers alone, the interest taken by the different classes is shown.

The American Foundrymen's Association membership is composed of all who are interested in the foundry business. This is a pretty broad specification, and the classes interested are practically all represented in the list of contributors this year. Of the twenty-eight papers and reports presented, four were prepared by foundrymen, six by metallurgists, two by accountants, five by individual foremen, one by the Cleveland Patternmakers' Association, the membership of which is composed of patternmaker foremen, three were reports by the secretary or committees, three were prepared by manufacturers, two by college professors, one by an editor, and one a report by Dr. Stratton, of the Bureau of Standards, at Washington, D. C. Each sees the problem from his particular angle, and by coming together and reading these papers and discussing the subjects, great good to all classes results.

This year there was one feature which was somewhat different from previous years. That is, that all the sessions were presided over by the president of the A. F. A. and all papers presented to the parent association. For the last two years the president of the Foundry Foremen's Association has presided at one session, at which most of the Foundry Foremen's papers were read. This was impossible this year for two reasons: First, it was impossible for the president of the Foundry Foremen to stay past the first day of the convention, and the secretary of the Foundry Foremen's Association was also absent. Second, greater good can be obtained by grouping the papers according to subjects than by grouping them according to authors, and hence in presenting them it is best to arrange them for presentation to the parent body.

The American Foundrymen's Association, however, owes a great debt this year to the Associated Foundry Foremen for their part in the preparation of papers, in the attendance at the convention, and for the general interest taken in the meetings.

It is to be hoped that by another year other sections will be developed, which will be equally beneficial to the association.



MEMBERS AND GUESTS OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION AT CLEVELAND.

Associated Foundry Foremen.

The business session of the fourth annual convention of the Associated Foundry Foremen was held at the American house, Cleveland, O., on the evening of June 4, with a large attendance. President David Reed presided, and in the absence of the secretary, Henry M. Lane filled the place. The early part of the session was devoted to the reading of minutes, appointment of the nominating committee and the reading of the secretary's report, which was presented by President Reed and included his report as well. It showed two new locals added during the year and 77 additional members, making a total of 334. The membership has almost doubled in two years. The report called attention to the importance of the apprentice question and the place of the foremen in his education. A plea was made for more general support of the association and its benefits were outlined. The financial statement showed a healthy condition of affairs.

Reports were received from a number of local associations, though several were not represented.

The feature of chief interest in the meeting was brought up by the reading of a communication from Secretary F. C. Everitt, recalling the object of the organization, as stated in the constitution to be "a strictly educational" one. Some instances of labor antagonism, he stated, had developed, and the idea that the association was involved in this sort of work had been spread by recent publications in *The Review* of the National Founders' Association and *The Iron Molders' Journal.* He suggested some action in this connection.

A motion that this communication be laid on the table was defeated, after the president had stated that it would be unwise to sidetrack the issue. Mr. Murphy then moved that the report be accepted and that a committee be appointed to consider the problem. This was carried and Messrs. Williams, McMakin and McKenzie were appointed. After a meeting of some length, this committee reported a set of resolutions, which did not prove entirely satisfactory, and a substitute resolution was adopted, as follows:

"Whereas, there has been published in various journals that the National Founders' Association had gained or was gaining control over the Associated Foundry Foremen for the purpose of using this association in its conflict with the iron molders' union. And

"Whereas, in accordance with our constitution such a course would conflict with the principal object of our existence. And

"Whereas, there is nothing in our constitution to prevent any of our members as individuals so desiring to join a local foremen's club, organized for the purpose of aiding the objects of the N. F. A. Therefore, be it

"Resolved, that we emphatically confirm Article 1, Section 2, of our constitution, which says: 'The object of this association shall be *solely educational*,' and further, be it

"Resolved, that any local organization forming a part of this association which violates Article 1, Section 2, of our constitution, shall be adjudged in bad standing with the association, and thereby forfeit its charter, as per article 5, section 4, of the by-laws. And further be it

"Resolved, that a copy of these resolutions be forwarded to every organization and publication interested."

The association was addressed briefly by President West, of the American Foundrymen's Association, who commented on the number of foundry foremen interested in educational matters, by Dr. Moldenke, who reviewed the progress of education in the molding industry, by Henry M. Lane, who told of the convention's plans and prospects and by others.

Officers were chosen, as follows: Hugh McPhee, of Bridgeport, Conn., president; Hugh McKenzie, of Cleveland, first vice president; A. T. Wil-

liams, of Philadelphia, second vice president; F. C. Everitt, of Trenton, N. J., secretary-treasurer.

Meeting of the American Foundrymen's Association.

The eleventh convention of the American Foundrymen's Association opened in Cleveland, Tuesday morning, June 5, with a record breaking attendance for the first day. The meeting was held in the large Central Armory, chairs being arranged for those in attendance at the session of the convention in the central section of the large auditorium, while on all sides were exhibits of foundry supplies, constituting the most elaborate display ever made at a convention. While the response of so many dealers in foundry supplies was indeed pleasing, there was necessarily considerable confusion at the opening session, as the placing of exhibits had not been completed, and the committee appointed by the association to attempt to suppress noise had all that it could do.

The address of welcome to the city of Cleveland was delivered by Mr. N. S. Calhoun, of the Johnson & Jennings Co., and was followed by the address of the president, Thomas D. West, on "The Need of Benefit of a Practical Education."

PRESIDENTIAL ADDRESS.

The American Foundrymen's Association was organized for the purpose of encouraging research in the art of founding; to disseminate the knowledge of its principles and to aid in the improvement of daily practice in all its branches. This may be considered an opportune time to speak of the numerous changes and improvements made since the organization of our society, and to call attention to opportunities for research as well as the necessity for new appliances and methods in our industry. There is ample material for a lengthy address on these matters, but as you have a number of excellent papers on varied foundry subjects before you, I have concluded to present a somewhat different line of thought, believing this to be both timely and important.

When we consider that the watchword of this association is "Education," your president feels justified in taking it for the subject of his discourse, and endeavoring to present that which may possibly help to advance our work and also benefit humanity.

Is the world improving? This is a question asked by many. The best evidence we have for the affirmative is the existence of such societies as this, and the constantly increasing number who are laboring to do good on the principle that we are free moral agents, left to work out our own destinies.

This is claimed to be a practical age. In considering the actual state of advancement in knowledge, and improvements in appliances, we are a far less practical people than conditions warrant. The vague conceptions and pernicious activities rampant among the masses, resulting from the teachings of misled reformers will, if not counteracted, so seriously disrupt our civil life and social customs that anarchy must find its opportunity to become so emboldened that we need have grave fears for the future.

We have men advocating reforms to better humanity who, if they were experienced in handling large bodies of operatives for whose results in creating profitable products they were held responsible, or who would lose all they possessed if not successful, would advocate lines widely different.

To understand the disposition and strength of a horse, one must work it, and the same may be said of a man. Those who have carried on any large industry, involving the employment of men of different abilities in offices, stores and workshops, where the need of competent workers is specially manifest, quickly learn what is required to better his labor. This is learnt in a manner that no theorist or any one inexperienced in the direct handling and managing of large bod-

ies of men can grasp. Especially is this true of busy times.

The impracticability and incompetency of the majority of men is responsible for more strife and poor living than all other evils combined. There is not one person in fifty who is the thoroughly practical and competent being that he can and should be, and there are few vocations that demonstrate this more than the foundry business. This deficiency is largely due to the fact that we do not give our youths the practical education and training they should have.

In the present strenuous times it is useless for any one to expect that any method for a permanent betterment of the social unrest can be used to harmonize the views and actions of the masses until we attain a nearer approach to needed practicability and competency in the units. This is not impossible.

One of the many habits that arrest the development of skill is drink. This and other defects subtract from the usefulness of employes so greatly as to excite wonder that large industries and operations can be carried on at all. To quote a recent expression: "Any one who had fancied that political and social reorganization would improve the cause of industrial labor, banish poverty and introduce the millenium, will be a wiser and a sadder man after he has contemplated the problem of competency. He will see in a very strong light the necessary relation of industrial competency and character to economic, civil and social improvement. Out of the mass of incompetents, indolent, vicious, unscrupulous citizens no magic can evolve order, stability, thrift and happiness. Improvement of the units is one essential preliminary to the improvement of society."

We might, as a people, go on from day to day and year after year, advancing doctrines for reform, in religious, political, economic and social lines and avail little or nothing to truly benefit men, unless we place a practical education as a paramount issue.

Tender the support and prominence due to the practical, and we will find that the visionary dreams of sentimentalists would so vanish in time that many of the bad habits now so injurious to man will not survive in the atmosphere of the common practical sense that would prevail. In fact, it can be said that with a practical education as it should exist, so little discord, strife, immorality and misery would be left that reformers would have little to do.

As one illustration of the impractical beings that are occasionally turned out by our educational institutions, building on home training, I will cite the incident of a high school graduate who, after several reprimands for wearing gloves at his work in a foundry, turned upon his foreman with the ponderous exclamation: "I will tell you why I wear gloves; I play the mandolin." Here was a person supposedly possessing a high degree of intelligence, but still unable to comprehend the difference in the demands of a dress parade and shop work. The lack of practical schooling built on unsound home training, as exhibited by the man wearing gloves in a foundry, is the making of our visionary reformers as well as anarchists.

Our schools and homes should be places to instill common sense and practical ideas into the minds of the young. Instead of this, they are often responsible for such theoretical views of life that their wreckage is found on every hand. With the lack of practical instruction on the part of over-indulgent mothers, careless or worse fathers, and yellow literature, is it any wonder we are so overwhelmed with mediocrity on every hand?

Our educational system needs a revision, which in turn will consist in proper home training. There was a day when the ordinary school education only was necessary to get a living, but the fact that any good thing can be abused has been so much forgotten in making up a curriculum that too great a number in the masses have gone daffy, cramming themselves

with the professional and classical book knowledge, in the belief that this would make them pre-eminent among men, as well as give them the means to earn a good living. Anything but work, and the giving over of one's self to ease, sport and pleasure, is the secret underlying the great waste of time in the reading of subjects that are of little or no value in mental and manual working classes. The allurements of a life of ease and refinement which the Caucasian race is so partial to, finds its expression in the pursuit of a professional or classical education, rather ignoring the manual because it may involve hard work and dirt. If this evil is not corrected, the day will come when all classes of law-abiding, self-respecting people will suffer keenly for the errors of impractical parents and instructors.

The present day training tendencies are such that many of the young are taught to think it discreditable to look forward to a life of labor other than that which will permit the individual wearing clean linen at all times and to bear the title of "gentleman" and "lady." Why should a clean, trim $1 per day clerk command any more respect than the begrimmed $3 a day artisan?

There are two factors which must be taken into account more fully in our educational system as well as in our home training, if better conditions are to be realized in the future, and these factors are: a practical education and manual skill.

When on every hand there are to be found young and old unable to attain a living for lack of the above mentioned factors in their education, when there is a great demand for manual skill and the latter as a rule requiring as much, if not more, time and effort to be attained as the schooling now in vogue, why, then should not skill be respected and encouraged more than it is?

No one can show that there is a lack of employment for manual skill. The secretary of the Bowery branch of the Young Men's Christian Association, in New York, stated that one-third of the men who apply to him for help in securing work, and the most menial kind at that, are college graduates. Go where you will, in this broad land of ours, and it is the impractical scholarly individual, and not the skilled artisan, who is found begging for employment, blaming governments and capital for their failure in life.

Encourage and advance practical educational methods, as well as home training as herein presented, and in a short period few would be applying in good times to any agency for employment. In other words the distribution of scholarly and skilled workers would be so evenly divided that good remunerative employment could be found for all, and not as now a famine for one and feast for the other, a condition decidedly unfavorable for prosperity in any country.

Not only are educational fads overdone to the great injury of the masses, as proved by the non-attainment of skill and the difficulties of mere book scholars to obtain employment; but it is demonstrated by the foolish conception many have of what should be the correct training for youths. As an illustration in this line we find a father who for 32 years has spent almost every spare moment of his life collecting tin-foil, until he had, at last reports, a ball weighing 617 pounds, and is now training his children to increase its weight when he is no more. It looks as if this father will not only have his children waste the best of their lives, if they are fools enough, in swelling the dimensions of this ball, but would like to keep his grandchildren doing likewise, until they have such a ball of tin-foil together that the yellow journals can dwell upon it as illustrating the great achievement of Mr. So-and-So's family.

In another case we have a mother training her son to follow the steps of a father whom the whole community condemned as being the worst enemy to law and order, because the artificial atmosphere she lived in prevented her realizing his true needs in the way of

an education. This conception of educational needs is not much worse than that found in many parents keeping their children well dressed, with a little spending money in their pockets, rearing them as pleasure seekers and loiterers, who, when they are compelled to rely upon their own resources, are often driven either to beg, steal or starve. It may do sometimes to risk a "gentleman's life" for millionaire's sons, but for others the earlier the youths are trained to work and shift for themselves the better men they will make.

The inability of thousands to make a good living by not being skilled workers, means their loss as producers, and means further the employment of hundreds of others to do little else than trying to prevent incompetent beings from sinking to the lowest depths of degredation.

The settlements and barracks of the Salvation Army, with their multitude of workers, affords examples of the good having to waste their lives to reform the bad. Here are thousands of individuals who must be supported at the expense of the producing class. If we had the practical schooling and home training to create workers that should exist, there would be far less depravity and a surprising increase of competent skilled operatives, who, by their own ability to earn good wages, would create a much greater need for the commodities of life. Thus industry and all that is commendable in morality and respectability would thrive and advance in a manner impossible by any other means in vogue at the present day.

In taking up the educational question directly we must see that it is necessary to confine our youths' education to that which can be directly utilized. The amount of time wasted in ornamental studies that can never be made use of ranges from one to four and often more of the most precious years of life, and passes many on to an age that they cannot take up studies or an apprenticeship which in a few years could enable them to make a good living. All children should have a common school education, but when they have attained this their parents or guardians should study and discover, if possible, the capabilities of their youths and then decide what vocation they shall be trained for. Even special study that is not a direct necessity to the usefulness of the vocation to be followed should be put aside. What is a necessity should be studied with zeal and a regard for the saving of all time possible. What sense is there in spending valuable time studying subjects which, because they cannot be utilized, will soon be forgotten?

Many claim that studies, though useless in a practical sense, serve as a mental training. It is a poor vocation in this day of advanced knowledge that does not give sufficient mental training in itself to develop the mind as is supposed to be done by studying Latin and Greek. It is not the actual studying along classical or professional lines that is wholly responsible for any refinement obtained, but rather more the environments of the college and its association with well bred individuals. There is no reason why any vocation involving mental labor to master the technical end of its workings should not train and refine a person sufficiently to enable one to carry himself in a confident, self-respecting and sensible manner in every day life.

There are very few of our educators who are in a position to comprehend the necessity of the practical as compared with the book work of the professional or classical. Every energy has been directed to perfecting the latter two tendencies, and now this should be done for the former. Good literature on the practical aspects of life and the attainments of skill can be made to serve as text-books to train and refine youths as much, if not more so, as studies on political economy, history and English literature. Once it is recognized that there is as much need of the practical as the professional, and text-books will be forthcoming that will change and better the

views of the masses in a way now impossible. It is not to be expected that a change of this kind can be made in a few years as the machinery of education is naturally devised at the present time for carrying out the contemporary tendencies. No person can be impressed with this fact more than those who labor to develop and sustain what is practical and good common sense. Even our universities and colleges are at the present time being driven to combat the evils of excessive sport and pleasure, which are unfortunately backed up by the public support that is tendered to the athletic games. The excesses in this line are now so injurious to the aims of these institutions, and as a consequence to the masses, that at a recent gathering in New York City of professors and instructors measures were taken to suppress the great attention and loss of time given to these games to the injury of collegial as well as practical laboratory work.

We have few factors more disregardful of the practical and common sense in life than that part of the public press which caters to the power of sporting, pleasure seeking and sensationalism; in fact, the "anything-but-work" public tendencies. Create a strong sentiment to advance the practical side of public questions and this class of publications will be forced to devote more space to the real advancement of the masses.

The great revolution in the tendencies of industries, which may be called "Specialization," that has taken place in the past ten or twenty years, is a move towards the attainment of practical science that has not received the recognition it deserves. It really means that no one should expect to completely master more than one vocation. There was a day when knowledge and means were so limited that one man could attend to many different things, but this day is gone forever. At one time an individual could undertake to be a master molder, machinist and blacksmith, but this is not possible now.

All those who are highly skilled in the art of founding naturally know that he who wishes to be in the lead, or the master of the sand-heap and cupola, either as a worker or manager of men, can spend every minute of a ten-hour day in the shop and his evenings in study and research during a long life, and still have much to learn.

To be a practical people we must, in connection with the other reforms mentioned, specialize our studies and labor so as to be masters of one vocation and a tinker of a very few—not "Jacks-at-all-trades and masters of none." The all-prevailing existence of the smatterer or "would be" is an affliction that causes many of our industrial enterprises great losses and perplexities. To the lower working classes it means high cost of living and often much misery, which is entirely uncalled for, and should not exist.

It is within the power of the civilized portion of the world to inaugurate a change in our studies that will prove very beneficial to mankind. We do not wish to ignore Europe in this work as the world is becoming more and more cosmopolitan every day; and to think of confining effort for a reformation in education to this country alone would not be doing right to mankind, especially when we are having foreigners coming to our shores by the thousands every week, and who are in de-

All those who are highly skilled in mand as much through the "anything-but-work" tendencies of the majority of our "should-be" workers as by any other factors. The way to start the reform required would lie chiefly in our leading associations appointing committees, consisting of men broadly experienced in the actual work of all the branches of the vocation they represent, to select the subjects to be followed by youths after reaching the close of the grammar school grades, to best fit them for the vocation they will enter, as well as to designate what the demands are for the employment of manual or mental skilled workers in their respective lines. These associations should include, among others, architects, blacksmiths, the business

XUM

professions, carpenters, chemists, civil engineers, draughtsmen, doctors, editors, electricians, farmers, masons, mechanical engineers, metallurgists, mining engineers, ministers, molders, patternmakers, painters, plumbers, and down the list to supply men, stationary engineers and wheelwrights.

A founder's committee would not, I think, recommend the waste of time by those wishing to learn the art of molding in studying subjects that could rarely if ever be utilized. In fact, it could be narrowed to a common school education, and a study of drawing, chemistry, and some metallurgy. The latter three could be taken after leaving the regular school, as special studies in day or night schools under some instructor or technical institution, where they know just how much of these studies the molder, foundry foreman or manager should possess. This committee, aside from recommending what special studies were necessary, could also set forth the title of such books as should be read at leisure, it being understood that a study means to memorize, but that a reading merely to form a fair conception of what did exist—all with the view that a man should not have to wait until he is nearly gray-headed before possessing a knowledge and experience enough to command a good living for him. We have only one life to live, and we should be fitted as early as possible to make the most of it.

This address may be considered in the light of an appeal for a reform in matters of education and home training, to create practical beings and good workers, to an association that, together with a few others, stands foremost in doing what can be highly commended by civilization. We have had martyrs in the past who have given up their lives for the good of others, and we have today men who are advocating reforms that would exact great sacrifice on the part of others. What greater sacrifice, however, and liberality of spirit, can be seen in present times than to perceive members of a body like the American Foundrymen's Association giving gratuitously to the world their trade secrets and experiences, as well as original researches, obtained at great expense, which but a few years ago, compartively speaking, all men would have held in their strong boxes?

We have socialism and other "isms" striving for public support, but few have discerned or at least given to this and other modern kindred associations and its workers credit for the putting aside of selfishness, the gratuitous distribution of information, and the creating of co-operation among rivals in trade beneficial to the masses as well as themselves.

It is hoped that this aggression on your time in not dealing more directly with questions of sand and iron, will be considered equally as beneficial, and may help to call public attention to a grave matter covering the welfare of the nation.

There are over five thousand proprietors of foundries and as many more superintendents and foremen combined with the allied interests, such as chemists, patternmakers and supply men, that should take great interest in our association's work. There are many who naturally do take a great interest, and those who do not would doubtless do so were they to attend one of our meetings or took the time to investigate the good work that has been accomplished by our association and members helping each other to advance knowledge and skill in the art of founding.

We are a body of men who have had our struggles the same as all pioneers in striving for advancement, and have among us workers who have been untiring in their labors to aid the good cause. When the work of our association is closely analyzed and the consequences realized, we are forced to concede that it has been of the highest educational character, doing commendable labor that should be assisted by all those connected with the foundry business.

While much good has been accom-

plished by our association, there is still greater work before us, but to do this properly we should have a much larger membership. It is to be hoped that this "Cleveland Convention" will result in giving an impetus in this direction. In justice to ourselves we cannot recede; we must enlarge and press forward. Can we say more in soliciting outside craftsmen to join us? The latch string is out, and "Welcome" is emblazoned above the door, inviting fellow foundrymen to enter and become one of us.

Education is our association motto, and by making it as practical as possible we can do a great good in helping to make this world grow better. This association and kindred societies will certainly have to labor for more practical methods of instruction if, as a people, we truly desire to develop the needed skilled artisans, or to obtain the greatest comfort and happiness for the masses. This is a condition that can and should prevail throughout the civilized world.

The Secretary's Report.

The indefatigable secretary-treasurer, Dr. Moldenke, read his report which was as follows:

In presenting a brief report of the activities of his office during the fiscal year just closed, your secretary begs to state that the affairs of the association are in satisfactory condition, its influence steadily rising, and its usefulness growing greater all the time.

The year has been one of exceptional activity in the foundry, but also so hampered by high priced materials, poor deliveries, and economic troubles, that on the whole few foundrymen look back upon it with satisfaction. We may except only those who have so far specialized their work that the foundry end needs only make part of the profit of the concern. These facts, peculiar as they may seem when taken in connection with the era of prosperity we are in, have been gathered by the voluminous and far extending correspondence, as well as personal interviews during the year. No wonder that the foundry is so sensitive to all kinds of disturbances, and the layman regards pig iron, which is without his knowing it the big item in the foundryman's bills, as the best barometer of trade conditions.

As a result of the reduction in the annual dues last year, the association has slightly increased its membership, having exactly three hundred members at the present time. Very strenuous efforts were made to obtain new members, both by correspondence, and personal interview. The association is well known in all parts of the world. Letters come from everywhere asking information, advice, and even plans and estimates for new foundry ventures. Everything possible is done to oblige the correspondents, and wherever possible the difficulties of engaging in new enterprises pointed out, in order to save loss on the one hand, and destructive competition on the other.

Perhaps the best criterion of the value of the association is the fact that other countries are following our methods with profit to themselves. Again, many local associations, organized for a variety of purposes, find it beneficial to discuss foundry problems of a technical nature at their meetings. Thus, the educational feature for which this association stands exclusively is widely recognized, and your secretary is often called upon to assist at these occasions. A new foundrymen's association has been formed on the Pacific coast, and had not the terrible disaster occurred there, we should have had some representatives of this very live part of the country with us today. We hope for renewed prosperity and a vigorous resumption of the industry along the west coast, and trust that we may hold one of our meetings there at no distant date.

The American Foundrymen's Association has been signally recognized by the election of your secretary as an honorary member of the British Foundrymen's Association, and further by his appointment on the national ad-

XUM

visory board for testing fuels and structural materials recently created by the president. Its members are on a committee now engaged in testing coke for the government in St. Louis, the plant which we expect to see a part of the magnificent institution in Pittsburg founded by Andrew Carnegie. Furthermore, our members are now at work in formulating standard specifications for foundry coke, in connection with the American Society for

EXHIBIT OF THE ARCADE MANUFACTURING CO.

Testing Materials. Thus our activity is ever extending, and for the benefit of our industry and the world in general. May we not hope for better support on the part of the foundrymen of the country?

The government, through its bureau of standards, has now formally taken over our standardizing bureau, thus closing a chapter in our life which has proven of great value to scientific founding as well as the iron laboratory. To our president, Mr. West, is due the credit for its inception and nearly all the labor of maintenance. The Case School, where we meet once at this convention, through its Professor Smith, also has contributed largely to the success of this undertaking, now well known throughout the civilized world.

With the taking over by the government of this work, it will be enlarged to include the steel industry, and possibly go into further branches of interest to foundrymen in general We hope for a wide field and all possible success in this direction.

Considerable progress has been made along the line of trade schools during the year. Our association is not in position to finance any such undertaking. It can but recommend and urge the need of these public improvements. Others are taking up the question, and are better able to carry it through. We rejoice with them that education is thus making headway, and we need not fear European competition quite so seriously as formerly. Let the good

work go on, however, it satisfies our pride to have done the preliminary labor.

We have again to thank THE FOUNDRY for the courtesy of printing our Transactions under an arrangement which gives them to us far below what it would cost us to handle the problem. We trust that this disinterested spirit will be duly rewarded in other directions.

The receipts and expenses for the fiscal year, are as follows:

Received for Dues, etc	$1,045.18
Standardizing Bureau	495.72
Total	$1,540.90
Disbursed for Salaries	$ 894.62
Printing	92.02
Transactions	154.25
Postage	233.00
Sundries	23.30
Total	$1,397.19

leaving a balance in the treasury of $143.71.

All of which is respectfully submitted.

RICHARD MOLDENKE,
Secretary-Treasurer.

Reading of Papers.

The report of the committee on trade schools by J. S. Seaman, chairman, Pittsburg, was submitted, the report being as follows:

In reference to the foundry department in the Carnegie Technical Schools I would say the work so far as I have been able to learn has been very successful. The engineering student is the one who derives the greatest benefit this year. Each one of the 120 students goes into the foundry each week and gets the practical side; they not only get the theory but are taught to do the real work. Aside from the best manner of putting work on the floor, they are taught the best practical way and consequently that must be the best commercial way.

They have a 42-inch cupola, the most modern equipped, and an electrical elevator to charging floor. These young men attend to the manipulation of the machinery; they also have the care of the cupola, the charging, the running off of the heats, as well as the pouring of the iron, and the care of the core oven. This gives them an idea in their early training of how the present methods are conducted, and through their ingenuity and skill they will become proficient designers, so as to make work more advantageous in the foundry in the future.

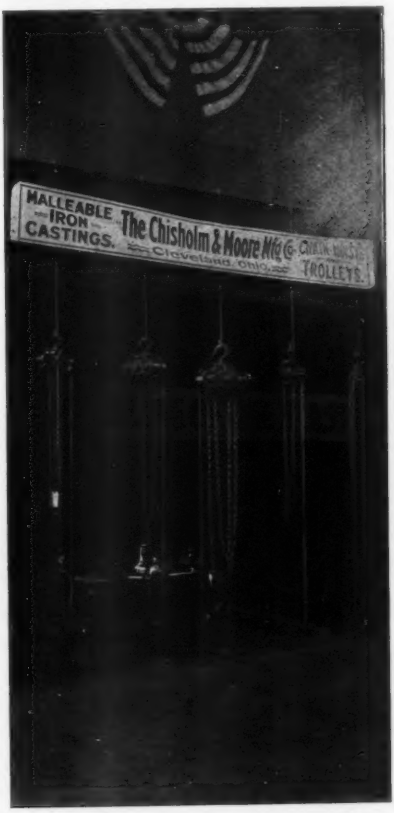
In the evening course for the trade, where only molders were taken, the advantages that these young men have had are very beneficial; they took the apprentice molder and aside from giving him the advanced work on the floor, they taught him mathematics and mechanical drawing; this you see, would not only enliven his mentality but fit him practically to read the drawings, calculate the weight of castings and the setting of cores; they also taught these young men the lining of the cupola, the charging, and the different mixes requisite for a certain kind of casting, and they laid considerable stress on vents as well as consistency of core mixes and sands.

Next year, as I understand it, they hope to start their regular evening class for advanced foundrymen; that is to say, they will have lectures on the foundrying of metals, care of the cupolas through actual demonstration; they will also give a course in chemistry to these men—the chemistry of iron and steel, the chemistry and mixes of iron, to tell what the mixing of the iron constitutes; i. e., carbon, silicon, sulphur, manganese, and phosphorus. These tests will be made in such a manner as to make them thoroughly practical, and the castings will be tested for their ability to resist transverse, tensile, crushing, and impact blows or strains which will include tenacity, elasticity, and toughness. These tests will be made in the laboratory upon testing machines; and the chemistry of sands will also be taken up by this class of men; they will get a certain amount of mathematics and drawing.

They have not been able to start in this department in their day school

as yet, but they hope to, just as soon as more buildings are completed and they have sufficient room.

If this school keeps up what it has started, we have no reason to believe but what this association will be greatly benefited and we trust that Director Hamerschlag will be able to carry out what he has so expressed to us: To make better foundrymen, make better molders, and to give the foundrymen what is their just due in the commercial world.



SOME CHISHOLM & MOORE HOISTS.

The following papers were then read: "The National Bureau of Standards and Its Work," by Director Stratton, Washington, D. C., and "Influence of Different Ore Mixtures on the Resultant Pig Iron, from the Standpoint of the Foundrymen," by General Manager W. K. Barrows, Shenango Furnace, Sharpsville, Pa. In the absence of Mr. Barrows, who was unable to be present, his paper was read by Frank L. Crobaugh, Cleveland.

Tuesday Afternoon's Session.

The session Tuesday afternoon was held in the hall on the second story to avoid the noise of the first floor. Kenneth Falconer, of Montreal, read a paper on "Uniform Practice in Foundry Cost Finding" and it was decided to appoint a committee of five to consider the advisability of appointing another committee to take action on cost keeping.

"Good Molders—Why Are They Scarce?" was the subject of a paper by U. S. McQuillan, of South Norwalk, Conn. E. H. Williams, of the Enterprise Foundry Co., Philadelphia, discussed the paper briefly, making a strong plea for the promotion of temperance among molders and urging that the union co-operate with the employes in this cause. He severely criticized the union for not demanding higher character of men in its membership.

E. H. Mumford, of Philadelphia, read a valuable paper on "Recent Methods of Machine Molding" and Dr. Moldenke described the foundry tests of coke made at the United States fuel testing plant in St. Louis. The paper was briefly discussed.

Wednesday Morning Session.

The third session of the convention was called to order in the Central Armory about 10:30. The first paper read was by E. M. Taylor, of Boston, and was entitled "Correct Application of True Burden to Iron Costs." In the absence of Mr. Taylor the paper was read by Mr. T. E. Crawford of the Library Bureau, Boston. A paper entitled "The Electric Crane in the Foundry" by Harry Sawyer, was read by the title only.

Following Mr. Sawyer's paper Mr. W. H. Parry presented his paper entitled "Dark Secrets in Foundry Practice." Mr. Parry is well known as a practical patternmaker and discussed

problems of the foundry from the standpoint of an outsider. He incidentally described the use of diamonds for cutting tools, the diamond being inserted in a steel holder and used as a lathe tool. While the cost of the diamond was much higher than that of a steel tool, the saving in time of sharpening and in wear more than compensated for the extra first expense. Mr. J. F. Webb inquired as to the cost of using diamonds for cutting tools and Mr. Parry replied that it was about $8.00 to $12.00 per carat. The stones, however, did not need to be sharpened once in six months. The method of preparing the tool was to make a hole in the steel holder in which the diamond was loosely fitted, and then brass solder was poured around it. The stone was sometimes ground before being placed in the holder and sometimes afterwards. Diamond dust was used for grinding and cost from $6.00 to $8.00 per carat.

Mr. James F. Webb next presented his paper on "Multiple Molds," on which there was no discussion. Following Mr. Webb's paper Mr. Ralph H. West read a paper entitled "Comparative Design and Working of Air Furnaces."

President West suggested that, as the paper was of great importance and the amount of time so limited, discussion be postponed until the next session, and then called upon Mr. N. W. Shed to read his paper entitled "Foundry Fluxes." The paper was discussed by a number of gentlemen, the first being Mr. G. M. Thrasher Jr., chemist of Western Tube Co., Kewanee, Ill. Mr. Thrasher described the conditions under which a cupola at the Western Tube Co. was run for eleven hours per day. The flux used was composed of 35 pounds of limestone and 15 pounds of fluorspar to each ton of iron. The amount of coke used was 300 pounds per ton of iron. They found that limestone alone was not adapted to long heats, such as the above, and that the fluorspar was necessary.

Mr. J. F. Webb told of the troubles of a foundryman who charged, in a 54-inch cupola, 7,000 pounds of iron to 1,800 pounds of coke. After the first couple of tons of iron came down it ran cold and Mr. Webb inquired the reason. Mr. Shed, the author of the paper, said that he thought that too much iron was used for the amount of coke charged, and that not over 5,000 pounds should be used with that amount of coke. Dr. Moldenke agreed with Mr. Shed that the amount of iron was too great, and said that not over 6,000 pounds should be charged.

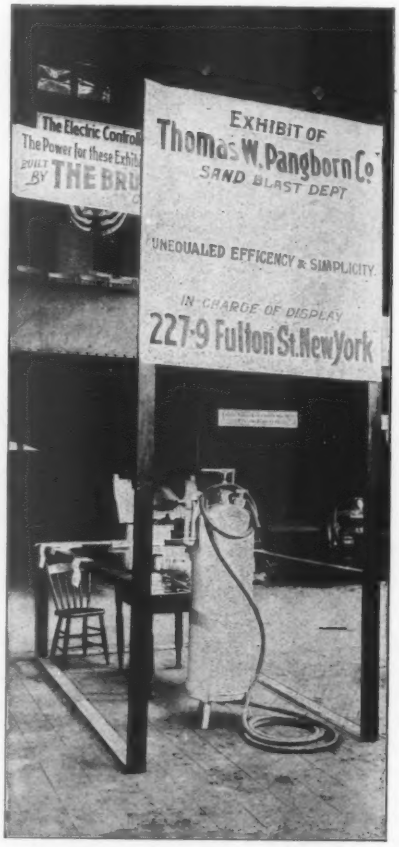


EXHIBIT OF THOMAS W. PANGBORN CO.

Mr. A. M. Loudon told of his experiences with the "Jumbo" cupola at Port Chester, N. Y., which ran con-

tinuously from 11 o'clock in the morning to 5 o'clock in the evening. Buggy ladles were used and the cupola was tapped from two holes alternately. The slag ran continuously. At 2 p. m. they stopped pouring the soil pipe fittings and went on stove plate. A trolley system was used for this work and there was a continuous line of men obtaining metal from the cupola.

Wednesday Afternoon.

In the afternoon of Wednesday the members and guests took cars at the Hollenden at 1 o'clock, which conveyed them first to the plant of the Brown-Hoisting Machinery Co., and then to that of the Welman-Seaver-Morgan Co., and the Electric Controller & Supply Co. They were entertained at these works, after which the

BERKSHIRE MOLDING MACHINES AT FOUNDRYMEN'S CONVENTION.

The flux used under these conditions was 60 pounds of limestone to the ton. They found that a charge of 7,500 pounds of iron gave the best results. Experiments had been tried from time to time in reducing the amount of flux and it had sometimes been brought down as low as 45 pounds of limestone to the ton. Under these conditions, however, the holes almost became stopped up and it was necessary to increase the charge of limestone at once in order to remedy matters. They had never used a flux on the first two charges of iron.

street cars conveyed them to the Case School of Applied Science, where a session was held in the lecture hall of the Electricity building. Prof. C. H. Benjamin, of Case School, gave an illustrated lecture, describing the tests which had been conducted by him on the strength of cast iron during the past ten years.

These tests consisted in the subjecting of cylinders to hydraulic pressure until they burst; the subjecting of plates to hydraulic pressure and to concentrated loads at one point; the testing to destruction of various cast

iron beam sections; and the testing to destruction of cast iron fly wheels and pulleys of various forms.

The lecture was illustrated with lantern slides and Prof. Benjamin pointed out numerous things which had been learned in the course of experiments. For instance, he found that in making a cylinder with flanges heavy enough to provide the requisite strength, blow

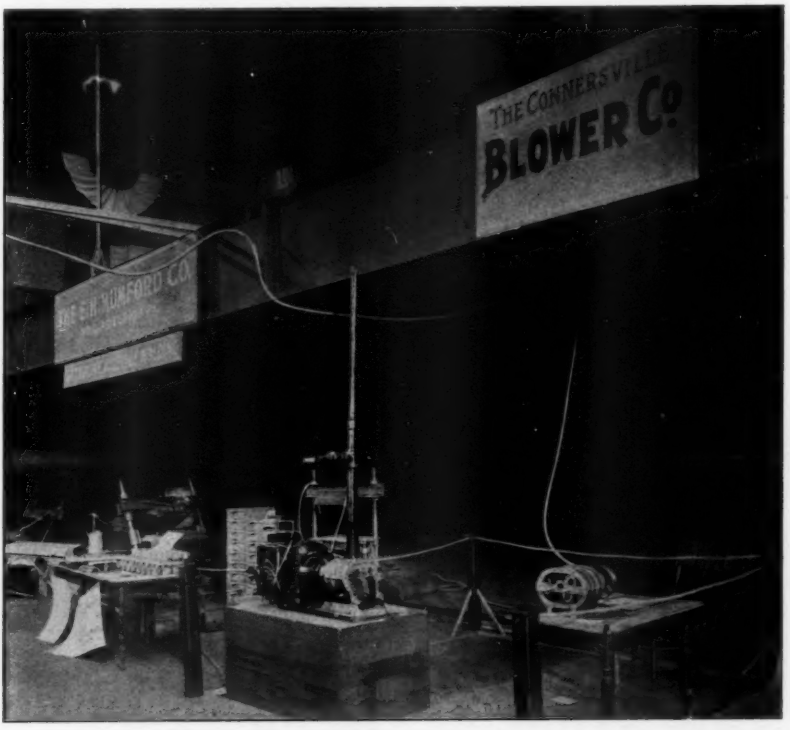
THE ELECTRIC CONTROLLER & SUPPLY CO.'S EXHIBIT.

holes would develop at the junction of the flange and cylinder. These weakened it so that the cylinder always failed, when the flange was to any great degree heavier than the cylinder wall, around the circumference of the cylinder immediately below the flange. In the course of the experiments he developed a cylinder in which both wall and flanges were of uniform thickness, the requisite strength being provided by ribs joining the flange and the cylinder. These cylinders on testing failed in the manner that they theoreticaly should: namely, in a straight line parallel to the axis.

Another interesting experiment carried on by Prof. Benjamin was the examination of breaking strength of gear teeth. The gear tooth was placed in a testing machine and broken by applied pressure. It was found that the breaking strength was very close to that calculated by formulae, and that the tooth always failed on a line parallel to the direction of the applied pressure. The strongest form of tooth was found by these experiments, to be the involute rack tooth. In general the involute tooth was much stronger than the epicycloidal.

The most interesting series of experiments conducted by the professor was the testing of wheels and pulleys to destruction. The pulleys were placed in a steel casing and driven by a steam turbine up to any necessary speed for breaking. The terrific effects of the bursting fly wheel were

illustrated by a photograph of the testing apparatus after it had been demolished by a particularly heavy wheel. The casing was constructed of 1¼-inch boiler plate strongly bolted, with a lining of 12-inch oak blocks. The bursting fly wheel completely demolished the casing, throwing the upper half something over 150 feet away and another portion of it on the roof of one of the buildings. The 1¼-inch boiler plate had broken clean off by the impact.



EXHIBITS OF THE E. H. MUMFORD CO. AND THE CONNERSVILLE BLOWER CO.

At the conclusion of the lecture the society tendered a vote of thanks to Prof. Benjamin. In the evening the members and guests of the society visited Luna park, one of the amusement places of Cleveland, in a body.

Thursday Morning Session.

The concluding session of the meeting was held Thursday morning in the course of a boat ride to Lorain, O. About 450 members and guests went aboard the steamer, "City of the Straits," at 9 o'clock Thursday morning and were conveyed to the works of the National Tube Co. at Lorain, 27 miles distant. During the trip, a meeting was called to order in the saloon of the vessel, and Mr. Archie M. Loudon read a paper entitled "Core Mixtures and Compounds." This paper dealt with 18 tests made by Mr. Loudon on cores made of various proportions of sand and compound, and with a number of different binders and compounds. Mr. Loudon's conclusions were interesting, as they gave the best proportions and binders for use in cores for different services and of different sizes. There was no discussion on the paper. Dr. Moldenke then

moved that all the other papers submitted at the convention be read by title and the discussion dispensed with. This was agreed to and the convention proceeded to the transaction of general business.

The first business was the election of officers. The nominating committee reported the following nominations for officers to serve for the year 1906-1907:

THE TABOR MFG. CO. AND THE CHICAGO PNEUMATIC TOOL CO.

President, W. H. McFadden, Mackintosh, Hemphill & Co., Pittsburg.

Vice president, first division, New England, C. J. Cayley, Russell & Erwin Mfg. Co., New Britain, Conn.

Vice president, second division, New York and New Jersey, John W. Burr, Brook & Houston Co., Brooklyn, New York.

Vice president, third division, Pennsylvania, Stanley C. Flagg Jr., Philadelphia.

Vice president, fourth division, Ohio and Illinois, J. H. Whiting, Whiting Foundry Equipment Co., Chicago.

Vice president, fifth division, Michigan, W. J. Keep, Michigan Stove Co., Detroit.

Vice president, Sixth division, Wisconsin, Thomas J. Sherriffs, Sherriffs Mfg. Co., Milwaukee.

Vice president, seventh division, the South, J. B. Golden, Golden Foundry & Machine Co., Columbus, Ga.

Vice president, eighth division, Canada, L. L. Anthes, Toronto Foundry & Machine Co., Ltd., Toronto, Ont.

Secretary-Treasurer Richard Moldenke, Watchung, N. J.

The nominating committee recommended that all section officers be appointed by the executive board of the association. On motion, the report of the committee was received and the secretary instructed to cast one ballot for all nominees who were then declared elected.

Mr. H. M. Lane then moved that the organization committee of the American Foundrymen's Supply Association, which was formed at this convention, as related in another column, be made a supplementary committee of

the American Foundrymen's Association, and this motion also was adopted.

Mr. J. G. Seaman, of Pittsburg, then stated that it had been the custom of the society to elect the retiring president to honorary membership in the association, and he therefore moved that Mr. Thomas D. West be so elected. The motion was carried by acclamation.

Dr. Moldenke spoke of the growth of the brass foundry business in the country, and stated that the need for an association of brass foundrymen was becoming greater each year, that while the American Foundrymen's Association welcomed all men engaged in the foundry business, he thought that the work of the brass founders could best be carried on by an organization devoted entirely to that purpose. He, therefore, moved that a committee be appointed to consider the formation of an American Brass Founders' Association with instructions to report at the next convention. The motion was carried, and a committee consisting of Mr. C. J. Cayley and Dr. Moldenke was appointed.

Dr. Moldenke also moved that a committee be appointed with Mr. J. S. Webb as chairman to study the use of nickel in cast iron and report at the next convention.

Mr. J. G. Seaman arose to express the appreciation of the society for the work of Dr. Moldenke in improving the organization and membership of the association, and in raising it to the high plane which it now occupies. He stated that the present position of the society was almost solely due to the doctor's work, and that he had been untiring in his efforts. He therefore moved a vote of thanks to the doctor. The motion was unanimously carried by a rising vote.

Dr. Moldenke responded in a few well chosen words, in which he expressed his appreciation of the spirit manifested toward him by the association. He stated that the American Foundrymen's Association was his best work, and that he thoroughly enjoyed working for it. For the past 10 or 15 years, he had devoted his entire time to it and had hardly spent

THE GOLDSCHMIDT THERMIT CO.'S EXHIBIT.

an evening in pleasure with his family. It gratified him exceedingly to learn that the society appreciated what little he had been able to do for it.

Mr. A. D. Belden, of the United States geological survey, then addressed the association briefly, and described the coke making experiments at the St. Louis coal testing plant. He stated that little or no investigation had been carried on regarding the subject of coke making. This was due to the fact that nature had provided a splendid grade of coking coal at Connellsville, which requires little or no attention while it was being reduced to coke. The present investigation was being carried on to determine the best methods of manufacturing foundry coke from the many bituminous fields of the United States. In the near future, a partial report will be published of the progress made, and later on, a complete report of the work done will be forthcoming.

An invitation was received from the Philadelphia Foundrymen's Association to hold the next convention in Philadelphia. As the selection of the place of meeting is vested in the executive board, the association passed a resolution recommending that the executive board select Philadelphia as the next place of meeting.

Mr. Field offered a motion tendering votes of thanks to the retiring officers of the association for the efficient administration which they had given it; to the authors of the various papers presented at the meeting; to the local committee for the splendid entertainment provided, mentioning especially in this connection, Mr. H. M. Lane, who has been untiring in his efforts and to whom the success of the meeting and the exhibits was largely due; and to the Philadelphia Foundrymen's Association for its invitation for 1907. The motion was unanimously carried.

Mr. Kenneth Falconer, speaking on a uniform method of cost finding, embodied the substance of his report in a motion to submit to a committee of two or three.

EXHIBIT OF THE WHITE TOOL & SUPPLY CO. AND THE CRESCENT MACHINERY CO.

which should report at the next convention, the question of a method of uniform cost finding applicable to the foundry business, and that members be requested to submit to this committee any suggestions which might be available. The motion was carried and the meeting then adjourned.

reaching town at about 4:30. During the return trip, a meeting of the newly organized American Foundrymen's Supply Association was held, as described on another page of this report. On its arrival in Cleveland, the association and its guests proceeded to the steps of the Chamber of Commerce where the photo-

CLEANING ROOM EQUIPMENT SHOWN BY W. W. SLY MFG. CO.

At the close of the meeting, luncheon was served on board of the boat, and by the time it was over, the party had arrived at Lorain. The association disembarked and went through a portion of the plant of the National Tube Works, visiting the Hulett electric ore unloaders, the blast furnaces, power plant and foundry. About two hours were spent on shore and the party then re-embarked and were brought back to Cleveland.

graph shown in connection with this report was taken.

AMERICAN FOUNDRYMEN'S SUPPLY ASSOCIATION.

In January, 1906, a group of foundry supply dealers in Cleveland met to discuss the advisability of holding an exhibition of foundry supplies and equipment in connection with the American

Foundrymen's Association convention in Cleveland, June 5-7. This resulted in the formation of what was known as the A. F. A. Exhibit Association, a local organization formed to conduct the exhibition in Cleveland.

J. S. Smith, of the J. D. Smith Foundry Supply Co., was elected president, and H. M. Lane, editor of THE FOUNDRY, secretary and treasurer. To provide funds for carrying out the preliminary work and to insure the work of the exhibit, the 11 members of the original association each contributed toward a guarantee fund which was paid in at once. Several meetings were held, the matter discussed thoroughly, and it was decided to rent the Central Armory, which is 120 x 207 feet, and to hold the exhibit and the convention in the same building. Letters were sent to all supply dealers throughout the country, and a large number responded heartily.

The exhibit, as carried out by the A. F. A. Exhibit Association proved very successful indeed, and on the second day of the exhibit, June 6, some of the exhibitors, together with a few supply men, held a meeting at the armory to consider the advisability of a perma-

THE FALLS RIVET & MACHINE CO.
OLLAND LINSEED OIL CO'S
AMOUS CORE OIL
THE FALLS RIVET & MACHINE CO.
CUYAHOGA FALLS OHIO
THESE CORES ARE MADE FROM
HOLLAND CORE OIL
MIXED AT 45 TO 1.

THE FALLS RIVET & MACHINE CO. AND THE HOLLAND LINSEED OIL CO.

nent foundry supply association for the purpose of financing the entertainment features of the annual conventions, and also for the purpose of carrying on an exhibit of foundry supplies and equipment each year in connection with the convention. The exhibit has proven to be such a drawing card at Cleveland that an unanimous opinion was expressed in favor of such an association. H. M. Lane was chosen temporary chairman, and first gave a statement of the history of the

Cleveland exhibit. The organization committee was then appointed to nominate officers and outline the business of the organization. This committee consisted of C. T. Smith, of the Chicago Pneumatic Tool Co., Cleveland, O., S. T. Johnson, of the Obermayer Co., Chicago, Ill., U. E. Kanavel, of the Interstate Sand Co., Cleveland, O., F. C. White, of the White Tool Supply Co., of Cleveland, and S. W. Hubbard, of Rogers, Brown & Co., Cleveland.

EXHIBIT OF THE WHITING FOUNDRY EQUIPMENT CO.

Some of the advantages to be derived from such an organization, as brought out in the discussion, were as follows:

The holding of an exhibit in connection with the convention would serve as a drawing card and make the conventions much more popular.

The fact that the supply men would look after the financing of all the entertainment features of the convention would relieve the A. F. A. officers of such work and leave them free to carry on the regular work for which the association was formed, namely: the advancement of foundry practice by the reading and discussion of papers; in other words, the promulgation of foundry literature and the education of foundrymen.

The forming of a regular supply association similar to the Master Mechanics, Master Blacksmiths and Master Car Builders, etc., would place all of the supply men on an equal footing, so that the expenses would be divided more equitably than has been heretofore possible.

Every convention has had marked examples of the means by which some people "sponge" on their more generous competitors.

By building up both associations, making the membership in each desirable and making the entertainment features exclusively for members, many of these abuses would be avoided.

On the return trip of the members and guests of the association from

Lorain the following day, a meeting of all the supply men on board the boat was called to order in the cabin of the vessel. Mr. Lane was made temporary chairman of the meeting, and briefly explained the business of the proposed association as outlined above for the benefit of those who were not at the preliminary meeting. He then reported that the organization committee had nominated the following officers for the association: President, S. T. Johnson, the S. Obermayer Co., Chicago; first vice president, E. H. Mumford, E. H. Mumford Co., Philadelphia; second vice president, E. A. Kebler, Matthew Addy & Co., Pittsburg, secretary-treasurer, H. M. Lane, THE FOUNDRY. These nominees were unanimously elected to their respective offices, and Mr. Lane then reported that the following committees had been recommended: Committee on constitution—C. T. Smith, U. E. Kanavel and F. C. White. Finance committee—H. E. Pridmore, John Hill, U. E. Kanavel, C. T. Smith, Jas. Darragh. Committee on entertainment—H. Evans, Wilfred Lewis, Geo. Borden, Chicago Pneumatic Tool Co., Philadelphia; John S. Wilberham, of the Baker Blower Co., Philadelphia; H. E. Mills, of the Syracuse Oil Co., Syracuse, N. Y.

These committees were all confirmed by the meeting and the president then called upon various gentlemen present to address the meeting and give their ideas upon the formation of the association and its objects. President Johnson first spoke briefly as to what was to be accomplished by the association, saying in effect what has already been outlined above.

EXHIBIT OF THE ATLAS CAR & MFG. CO.

Dr. Moldenke then stated that such an association had long been needed as the convention sometimes proved a great burden to the local committee and that it necessarily detracted from the real object of the association.

President elect McFadden of the American Foundrymen's Association, spoke in a similar vein, stating that the new administration expected to accom-

plish great things now that the co-operation of the supply men was assured.

Mr. Johnson called on Mr. John A. Penton, of the Penton Publishing Co., for his ideas on the association. Mr. Penton said that 10 years ago he would not have believed it possible that the American Foundrymen's Association could attain the commanding position which it today occupies, and he predicted that in the next 10 years the improvement would be as great and that the increase in membership would keep pace with the improvement. He stated that the difficulty of providing for the entertainment features for a society like that of the American Foundrymen's Association was appreciated only by those who had done so. It was unfair to the association to compel it to bear the burden of a varied and expensive entertainment, the chief benefit of which was reaped by the supply men and he was glad to see that the supply men were now ready to do their part. He suggested for the benefit of the committee on constitution that membership in the Foundrymen's Supply Association should be conditional upon membership in the American Foundrymen's Association, and that no one be allowed to exhibit at a convention of the latter association unless he was a member of the supply men's organization. Mr. Penton then spoke of the educational value to foundrymen of the American Foundrymen's Association, and stated that it would repay the owners of foundries many times over to send their foremen to their conventions and pay their expenses.

THE EXHIBIT OF THE OSBORN MFG. CO.

ENTERTAINMENT FEATURES.

The local entertainment committee had prepared an elaborate entertainment program for the visiting guests.

On Tuesday evening there was a theater party at Keith's Theater. The entire ground floor and a portion of the balcony was reserved for the members and their friends, and all reported a good time. Some of the actors found the names of some of the distinguished body before them, and showed that

they were familiar with Tommy West, the president, who was reported as still mixing iron by analysis; with big, tall Ben Fuller from Pittsburg; and with Field, of metallurgical fame.

On Wednesday evening the members and guests went to Luna park in a body, six trolley cars having been engaged for the purpose, and the party headed by a brass band. At the park the various attractions were taken in and the band was everywhere in evidence, being taken over the roller coaster, the "figure eight," the "shute-the-shutes," and all the other attractions visited by the members. Everyone reported a good time and went home tired but happy.

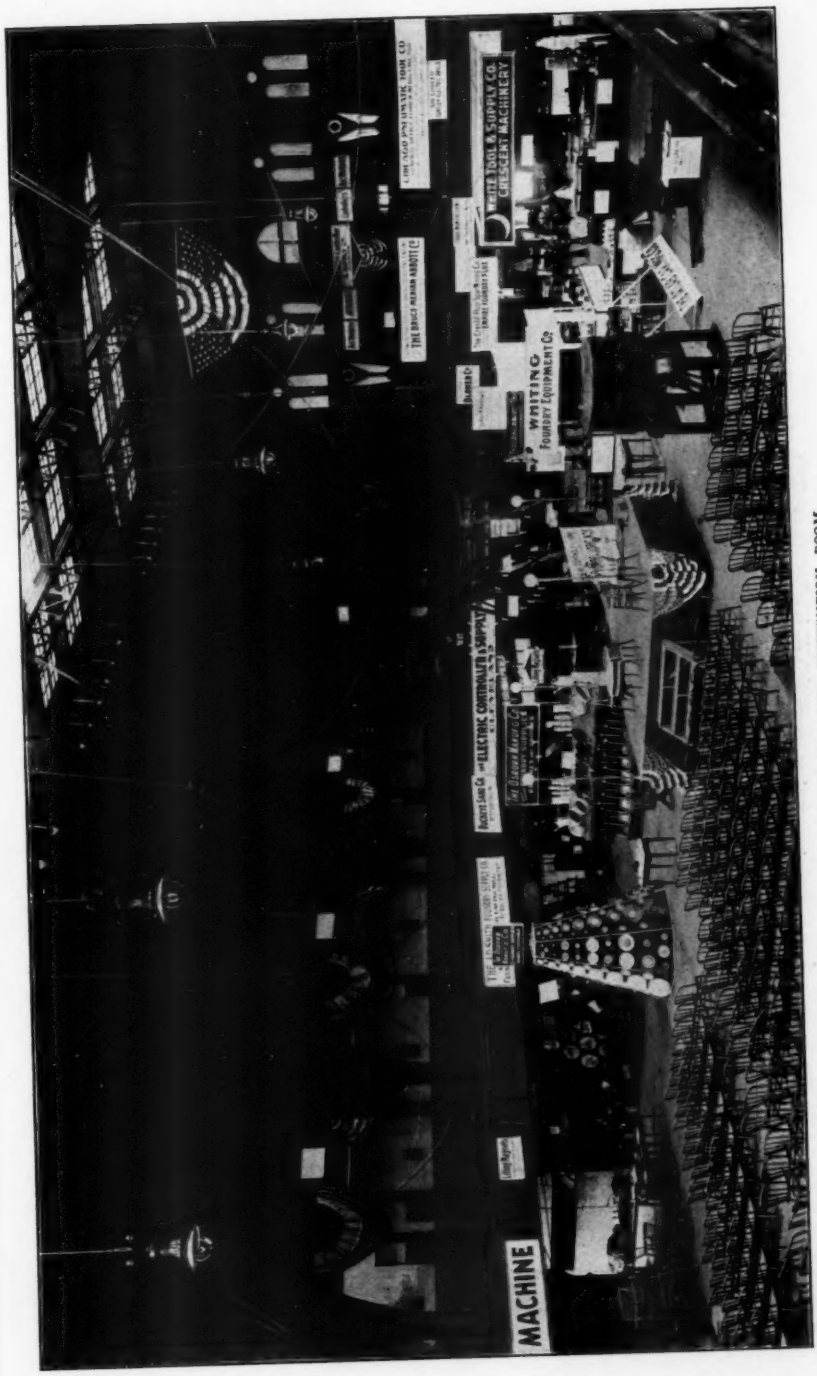
On Thursday the entire party went to Lorain on the steamer City of the Straits. As already stated, a session of the A. F. A. was held on the boat on the way out, and the organization session of the American Foundrymen's Supply Association on the boat on the way back.

At Lorain the party landed at the docks of the National Tube Co., which are three miles up the Black river. The guests were met at the dock by Mr. Masterson and his corps of assistants, who conducted the party about the works. The vessel unloaders were first inspected, where two Hulett unloaders were engaged in removing a cargo from one of the 10,000-ton ore freighters.

THE EXHIBIT OF THE J. D. SMITH FOUNDR Y SUPPLY CO.

The blast furnaces were next visited, and then the foundry. The foundry contains many points of interest. The entire product is used at the various mills owned by the company and consists of three classes of metal; that is, cupola, air furnace, and direct blast furnace metal. The cupola metal is used for ordinary work, the air furnace metal for rolls, and the direct metal for ingot molds.

On Thursday evening the final event of entertainment features took place, in the form of a smoker, which was held in the Central Armory, where the exhibits were arranged. The guests were seated at tables, when



THE EXHIBIT AND CONVENTION ROOM.

they were furnished with their molders' tools, which consisted of a souvenir stein, a corn cob pipe, and a bag of tobacco. The Falls Rivet & Machine Co. also presented each person in attendance with a leather case containing "sample cores," which were stated to have been made on the Wadsworth improved core machine. The cores were all cigar shaped and were made of a very fine quality of tobacco, and hence were put to use by the guests.

Very acceptable music was furnished by Steele's orchestra, which is a local orchestra of eighteen pieces. Amusement was also furnished by a vaudeville entertainment of eight acts.

POURING OFF THE HEAT.

Sandwiches were passed, and lest the members become too dry, liquid refreshment was furnished by pouring off a heat. This was accomplished with the aid of a cupola, furnished by the Whiting Foundry Equipment Co. It was stated that the Whiting Foundry Equipment Co. had occasionally furnished amber-colored liquid refreshments, but never before had it been drawn from a cupola of their make. The cupola was placed on the floor next to the platform, or stage, and was so arranged that the liquid refreshments were tapped from the spout into handladles, and thus carried by the waiters to the various guests at the tables. The steins were filled from the handladles, but as there were some 750 people present, it was found impossible to draw the material from the cupola fast enough, hence one of the steel barrels furnished by the Cleveland Wire Spring Co. was pressed into service. This was mounted on a truck, so that it could be carried from place to place, was filled with beer, and trucked down to the middle of the room. The handladles were then filled by dipping from the barrel.

The molders' tools were distributed to the members from wheel-barrows furnished by the J. D. Smith Foundry Supply Co., and tote boxes furnished by the Cleveland Wire Spring Co.

Considerable amusement was furnished by the local committee passing a number of cigars containing concealed springs, which let go after the cigar had burned a certain distance and scattered the tobacco.

The assemblage broke up at 10:30, everybody saying that the convention had been the most successful and enjoyable in the history of the Association.

The Exhibition.

When the first arrangements were made for the convention, an association was formed for the purpose of conducting an exhibition of foundry supplies, as explained in the report of the American Foundrymen's Supply Association.

When the convention opened there were exhibits from 42 firms. Some of the exhibits were composite exhibits of two or more firms. The total weight of the machinery and supplies exhibited was over 150 tons, and an idea of the work connected with the exhibit can be gained from the fact that this entire mass of material was moved into the armory in two days and set up and running when the convention opened. After three days of exhibit it was all torn out and reshipped in two days. Power for the exhibit was furnished by a 55-horsepower gas engine, installed by the Bruce-Meriam-Abbott Co., Cleveland, O., belted on one side to a 2-inch line shaft 90 feet in length furnishing power to the various power exhibits, and on the other to an air compressor, fur-

XUM

nished by the Chicago Pneumatic Tool Co. The air lines running the various exhibits required over 400 lineal feet of piping to reach the different exhibits. There were also over 300 feet of gas lines laid to reach various exhibits. in addition to the power furnished by the gas engine, three of the exhibits were

EXHIBIT OF THE B. F. STURTEVANT CO. AND THE REPUBLIC BELTING & SUPPLY CO.

driven by electric motors requiring an aggregate of 25 horsepower. The Electric Controller & Supply Co. also used a heavy current for its lifting magnets.

The various exhibits are described in greater detail below:

The Exhibits.

The Cleveland Wire Spring Co., of Cleveland, O., had a very interesting exhibit of steel foundry barrels and metal tote boxes, for use in foundries and other manufacturing establishments. These barrels are only about 50 per cent heavier than wooden barrels and are many times stronger and their life very much longer. They will absolutely pay for themselves in a short time in the saving of broken barrels and particularly in the saving due to the fact that when these barrels are used a certain aggravating occurrence never take place. In other words, all who have used wooden barrels are familiar with the breakdown that often occurs in the gangway and sometimes takes three men to clean up, and in the meantime blocks all passage in that department. Metal barrels do not break down. Some barrels are also provided with trunnions and a special truck arranged for handling them.

THE FOUNDRY exhibit was used large-

ly as a bureau of information and headquarters for the many friends of THE FOUNDRY. Copies of the different papers published by the Penton Publishing Co., and also a number of practical books on foundry practice were shown and subscriptions taken for the same. For the convenience of the visitors a stenographer was present who was ready to write letters for any one having business to transact.

The Western Foundry Supply Co., East St. Louis, Ill., occupied the adjoining space. This exhibit consisted of a number of glass jars containing various products, such as metallic cement, parting compound, various facing compounds, ground ferro-silicon, ferro-manganese, etc. The company also distributed souvenir bags of ferro-manganese.

The American Sand Co., Columbus, O., had an exhibit consisting of a series of sand bins containing various grades of molding sand, before which were arranged tables containing jars of molding sand and silica sand. One of the features of the exhibit was a number of cartoons posted on the railing in front of the space.

The B. F. Sturtevant Co., of Boston, Mass., had a number of features in its exhibit which were of especial interest. At the front of the exhibit was a sectional model of the latest patent of high pressure blower, manufactured by this company. The model was driven by an electric motor and illustrated very nicely the action of this new type of machine. The exhibit also contained three of the firm's well known centrifugal fan blowers of various sizes. Mr. W. H. Coleman, of the Chicago branch, was in charge, assisted by Mr. S. C. Cutler, who represents the B. F. Sturtevant Co. in Cleveland.

The Republic Belting & Supply Co., of which Mr. S. C. Cutler is vice president, had an exhibit of belting, foundry supplies and Cortland corundum wheels. As Mr. Cutler is connected with both firms, the exhibit was shown in connection with that of the B. F. Sturtevant Co.

Harbison-Walker Refractories Co., Farmers' Bank building, Pittsburg, Pa., displayed some of its blocks and fire brick for lining cupolas.

W. W. Lindsay & Co., Philadelphia, Pa., had an exhibit of chaplets of all classes and gave away a very neat chaplet souvenir in the form of a paper weight.

The Diamond Clamp & Flask Co., Richmond, Ind., had on exhibit a Gartside core machine for making round cores with coned ends, also for making irregular cores, such as pipe bends, etc. The machine is quite unique in its design and construction. The exhibit also contained universal couplings, pattern dowels and other devices manufactured by the company.

The Interstate Sand Co., Cleveland, O., which handles the product of the Ayers Mineral Co., of Zanesville, O., the Ohio Sand Co., of Conneaut, O., of L. K. Brown, Zanesville, O., the Gordon Sand & Gravel Co., Cleveland, O., and the Central Silica Co., of Zanesville, O., had a unique exhibit, including jars containing the different grades of sand handled by the company and advertising matter concerning it. The two most attractive features in the booth, however, were a microscope for the examination of sand and a pair of water coolers for dispensing pure drinking water. This latter feature proved a great attraction on the hot days.

The Berkshire Mfg. Co., Cleveland, O., exhibited two of its automatic molding machines, one being connected up with a revolving sand riddle and used for making molds for a plate of fittings. The other machine was connected with the power and ran idle, so as to show the mechanism. There was also on exhibition a small aluminum model of the machine and a large collection of castings molded upon the Berkshire machines.

The J. D. Smith Foundry Supply Co., Cleveland, O., had a combination exhibit, including facings and other foundry supplies manufactured and handled by the company. A squeezer molding machine made by the firm,

XUM

the Battle Creek sand sifter, a new sand sifter made by the Taylor & Boggis Co., brass melting furnaces, and lifts or hoists for pulling pots were also shown. A water tumbler and an exhibit of chaplets made by the Cleveland Chaplet Co. were also shown as was an exhibit of paints and paint materials.

The Buckeye Sand Co., of Pittsburg, had an exhibit of the various grades of molding sand handled by it.

The Wellman-Seaver-Morgan Co., Cleveland, O., had an exhibit of drawings of foundries.

The E. H. Mumford Co., of Philadelphia, exhibited two of the latest improved Mumford molding machines and one of the Rathbone multiple molding machines, and also an exhibit of castings made upon the Rathbone machines.

The Herman Pneumatic Machine Co., of Zelienople, Pa., had on exhibition one of its large pneumatic jarring molding machines, which was in operation. The molds were lifted off by a pneumatic hoist which ran on a trolley overhead, furnished by the Chicago Pneumatic Tool Co., Chicago.

The Electric Controller & Supply Co., Cleveland, had one of the most spectacular exhibits on the floor. This consisted of an electric lifting magnet, of two tons capacity, suspended from a special framework by means of an electric hoist. A couple of tons of pig iron were placed on the floor underneath the magnet, and elevated by it. After they had been raised about six feet, the current was cut off from the magnet and the iron allowed to drop, when the operation was repeated.

The Connersville Blower Co., Connersville, Ind., had on exhibit a sectional blower showing the manner in which the rotators worked and also a small blower driven by an electric motor.

The Thomas W. Pangborn Co., New York city, exhibited the American Diamond sand blast, the exhibit being in charge of J. B. Botham, sand blast engineer.

The Crystal Fluor Spar Mining Co., with headquarters in the American Trust building, Cleveland, O., had on exhibition samples of fluor spar, which sold under the name of Empire foundry flux.

The Goldschmidt Thermit Co., as usual, presented one of the most interesting exhibits in the hall, a detailed description of which would occupy a large amount of space. There were samples cut from welds of various types, made by thermit, and cut through the weld, showing the accuracy of the workmanship. There were clamps and molds for all classes of thermit welds, and illustrations and photographs showing some of the many applications of the thermit. One very interesting feature of the exhibit consisted in a collection of various metals, free from carbon, which were manufactured by the thermit process. Daily demonstrations of the use of thermit were given, including welding, burning on, and other uses. The exhibit was in charge of Mr. A. M. Guenther. Mr. E. Stutz, vice president of the company, was also present at the convention and spent much of his time at the exhibit.

The Tabor Mfg. Co., of Philadelphia, exhibited two pneumatic molding machines, a roll over molding machine and a Taylor-Newbold saw which is of especial interest to steel foundrymen. The roll over machine attracted a large amount of attention.

The Chicago Pneumatic Tool Co. had on exhibition an air compressor which was driven by a gas engine furnished by the Bruce-Meriam-Abbott Co., Cleveland, O., also a collection of pneumatic tools and appliances including hoists, hammers, drills and other pneumatic tools. These were all exhibited in operation.

E. A. Dempwolf & Sons, York, Pa., manufacturers of hydrofluoric acid, had a space to serve as headquarters for the distribution of literature.

The Buckeye Milling Co., of Cleveland, O., had an exhibit of cores made with its Wago dry core compound and

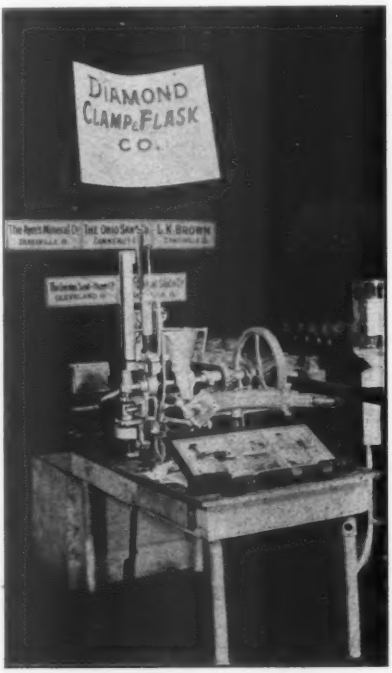
gave away samples of the compound in pound boxes.

The Atlas Car & Mfg. Co., of Cleveland, O., had on exhibition a section of industrial railway with a switch and truck, also a dump car and a turn table.

The Osborne Manufacturing Co. had the space in the center of the hall, directly in front of the main entrance. In the center of this space was arranged an octagonal pyramid, each face of which was covered with a different type of brush. There were hard and soft bristle brushes, wire brushes of all types, both for power and hand use, and in fact, the layman would be bewildered by the array of brushes which the various specialties in the different branches of the business have brought into existence. At one side of the pyramid there was a stand, upon which were exhibited molders' riddles and shovels; also blue-skin belt lacing. This is said to be the toughest and best belt lace leather manufactured anywhere.

William Dobson, manufacturer of molders' tools, of Canastota, N. Y., had a very attractive exhibit, consisting of a hardwood stand supporting columns carrying an elevated shelf. Upon these were arranged a large variety of molders' tools. The tools were all carefully finished, and while none of those present, probably, ever expect to earn their living again with the use of the rammer, trowel and slick, they were, nevertheless, very much interested in the display, and many of them will undoubtedly recommend these tools to their employes in the future. This exhibit was made especially efficient by the fact that Mr. Dobson and his assistant, Mr. L. H. Hough, were always present and ready to answer any number of questions. The souvenir aluminum scale given away at this space was an additional drawing card.

A. Brandau, of Detroit, had on exhibit his well known brand of molders' shoes. The leather in these shoes is treated by a secret process, which renders it to a large extent fire proof. Samples of the leather were introduced into the flame of a candle until the leather twisted and curled, after which it could be straightened out, bent, twisted, or pulled, as though nothing had happened to it. These shoes are especially designed for use in the sand heap and are gaining friends among the molders every year.



MR. GARTSIDE'S NEW CORE MACHINE.

The Monarch Engineering Co., of Baltimore, Md., had on exhibit one of the Monarch furnaces, which, unfortunately, could not be operated in the exhibit hall, as natural gas was not available. The original plan was to operate this furnace and pour off some of the molds made on the molding machines. The next best arrangement was made, which was to install a furnace in the exhibit, which was not in operation, and another at the shop of the Eastern Ohio Gas Co., which was in operation. Many of the visitors were taken to see this latter furnace, and interesting demonstrations of its efficiency made.

The Whiting Foundry Equipment Co., of Harvey, Ill., had on exhibit one of the latest type of 44-inch cupola furnaces. This was arranged with upper and lower tuyeres, slag spout, and all the modern improvements. The cupola was mounted next to the speaker's stand, and as described elsewhere, was used for drawing off the liquid refreshments the night of the smoker. The kegs were arranged back of the speaker's stand and a block tin pipe line laid into the cupola and sharpening stones, grinding wheels, polishing material, belt lacings, and other similar materials.

The Arcade Mfg. Co., of Freeport, Ill., exhibited two of the Arcade "Modern" molding machines. These machines are hand operated and ram both cope and drag at the same time. The exhibit contained a large number of castings made on this machine and molds were made at a very rapid rate. A statement at the exhibit shows that one of the men, shoveling his own sand

EXHIBIT OF THE STANDARD SAND & MACHINE CO.

through an ice box arranged inside of the same. The spout was made up in the ordinary manner, the block tin pipe being concealed in the lining of the spout.

The White Tool & Supply Co., of Cleveland, O., had one of the most attractive displays at the convention. This company is agent for the Crescent Machinery Co., of Leetonia, O., and hence had on exhibit a complete line of patternmaking machinery, including one of the most recent models of the Crescent band saw, a Universal saw table, and a surfacer. The Fox trimmers were also exhibited. In addition there was a complete line of

from the heap, has made and poured 275 molds per day of seven hours, using an 11 x 16 flask. These molds required approximately 1,200 pounds of melted iron. In the photograph, unfortunately, one of the machines is almost directly behind the other so that they do not show off to special advantage. One feature of the machine is a very ingenious method which is used for making the necessary match plates. After the two parts of the mold are filled, struck off and rammed, they are rolled over and the pattern drawn up from the mold. The parts are then drawn forward on to an apron, the mold assembled, and the snap flask removed.

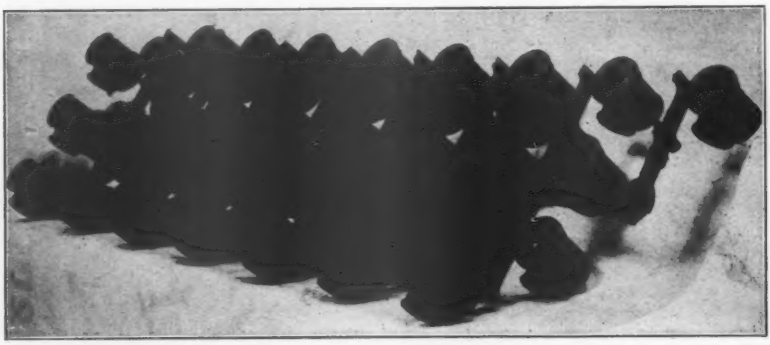
The sand for this exhibit was furnished by the Garden City Sand Co., of Chicago, Ill.

The Chisholm & Moore Mfg. Co., of Cleveland, O., occupied the space next to the Arcade Mfg. Co., and displayed five of the well-known Chisholm & Moore chain hoists. The operation of the hoists was also well illustrated by sectional models.

The Detroit Foundry Supply Co., Detroit, Mich., had a space and desk next to that of the Chisholm & Moore Mfg. Co., and had on exhibit its newly patented Galvarim riddle. This is a new departure in riddles. The rim is made of galvanized iron, with the top and bottom beaded over 3-16-inch iron wire. The screen is formed over a wire rim, and held in place by a groove near the bottom of the riddle frame. These screens can be replaced when worn out, thus greatly increasing the life of the riddle. The representatives of this company, Messrs. Crandall, Woodison and Beers, were in constant attendance at the convention, and we presume that the next edition of *The Blast* will contain many interesting features.

The gas engine has recently come into the foundry as a source of power, and every year sees more gas or gasoline engines installed for this purpose. Recognizing this fact, the Exhibit Association was very glad indeed to have on exhibit one of the latest types of gas engines, which was furnished by the Bruce-Meriam-Abbott Co., of Cleveland. The one shown was a 55-horsepower engine and operated an air compressor in the exhibit of the Chicago Pneumatic Tool Co., and a line of shafting 90 feet in length for driving some of the power exhibits. The engines of this type have an ignition at each stroke but the governor regulates the gas used so as to produce a uniform speed with any load.

The W. W. Sly Mfg. Co., Cleveland, makes a specialty of cleaning room equipment and had on exhibit a number of well-known machines of its make. These included a pair of exhaust tumbling mills, connected with a dust arrester of the latest type. A representative of the company went to one of the local foundries and secured a quantity of tumbling mill dust which was put into the tumbling mills, blown into the dust arrester, and the air which came out into the room was perfectly clean, thus showing the efficiency of the device. The statement was made that this air could be blown across the top of a desk without soiling the writing paper. In addition the exhibit contained one of the Sly water cinder mills, with all of the accessory mountings. There was also on exhibit one of the heads for a tumbling mill and one of the gears, showing the workmanship on both.



SOME OF THE WORK OF THE RATHBONE MULTIPLE MOLDING MACHINE.

The Standard Sand & Machine Co., of Cleveland, O., exhibited two types of sand-preparing machinery, one of which was in operation. This company manufactures machines so ar-

ranged that they will make any desired mixtures from a number of grades of sand. In this case all the operator has to do is to keep the machine supplied with the various classes and it will mix and temper the material which is required. Sand mixed in this way runs much more uniform than hand-tempered sand and is also much more economical, as a large proportion of old sand or local sand can be used in the mixture. The exhibit also contained a large variety of the molding sands handled by the firm.

George H. Wadsworth, of the Falls Rivet & Machine Co., Cuyahoga Falls, O., has made a specialty of core-room

THE MONARCH ENGINEERING & MFG. CO.
THE STEELE-HARVEY CRUCIBLE BRASS FURNACE
MONARCH BLOWERS, RIVET FURNACES, BURNERS, CORE OVENS, MOLDS
MACHINERY &c. Also Shipped

THE MONARCH ENGINEERING CO.'S EXHIBIT.

equipment, and by far the largest proportion of this exhibit was made up of core-room specialties. The well-known Wadsworth core machine was on exhibit, there being three machines in operation. One was driven by a compressed air motor, one six-inch machine was driven by hand, and a smaller machine by hand. There was also on exhibit a very neat core oven which has recently been designed by Mr. Wadsworth especially for the drying of machine-made cores. The Wadsworth core-coning machine, recently illustrated in these columns, was included in the exhibit, as was also the Wadsworth tumbling barrel. A large number of oil sand cores made upon the Wadsworth machine were shown, including squares, octagons, ovals, and other irregular forms. The cores vary in size from ⅜ of an inch square to ⅞ inch in diameter.

Adjoining the exhibit of the Falls Rivet & Machine Co., was that of the Holland Linseed Oil Co., of Chicago, Ill. Mr. Baumgardner had on exhibit a number of remarkable cores which were made with the Holland core compound. One core was for the interior of a hollow casting used in a steam laundry machine. The core was nearly eight feet in length, 16 inches in width, and 4½ inches in thickness at the center. It was entirely surrounded with metal, with the exception of two small holes at the ends through which the vent was removed. The casting had to stand 80 pounds of steam pressure per square inch. There were a number of other remarkable cores in this exhibit.

Those in Attendance.

Abell, Fred A., Interstate Foundry Co., Cleveland.
Abell, O. J., *The Iron Trade Review*, Cleveland.
Adams, Ezra S., *The Iron Age*, Cleveland.
Adamson, R., The Farrel Machine Co., Ansonia, Conn.
Adams, W. J., S. Obermayer Co., Milwaukee, Wis.
Aikens, M. H., Berkshire Mfg. Co., Cleveland.
Aland, Chas., Jas. B. Clow & Sons, Newcomerstown, Ohio.
Allyne, E. E., Allyne Brass Fdry. Co., Cleveland.
Allyne, A. H., Allyne Brass Fdry. Co., Cleveland.
Ames, Lyman, Columbus Iron & Steel Co., Columbus, Ohio.
Anderson, Axil, Moline Plow Co., Moline, Ill.
Andrews, Russel R., The Vulcan Fdry. Co., Hamilton, Ohio.
Anthes, S. S., Toronto Fdry. Co., Toronto, Ont.
Antisdale, Nelson, Ideal Mfg. Co., Detroit, Mich.
Armstrong, G. H., Matthew Addy & Co., Pittsburg, Pa.
Armstrong, J. H., Oliver Machinery Co., Grand Rapids, Mich.
Arnold, H. C., A. Carpenter & Sons Fdry Co., Providence, R. I.
Atwater, H. R., Osborn Mfg. Co., Cleveland.
Ayers, E. M., The Interstate Sand Co., Zanesville, Ohio.
Backert, A. O., *The Iron Age*, Chicago.
Bair, Adam W., Chicago, Milwaukee & St. Paul Car Wheel Fdry., Milwaukee, Wis.
Baird, N. E., C. E. Mills Oil Co., Syracuse, N. Y.
Baldwin, H. W., T. H. Symington Co., Corning, N. Y.
Baldwin, L. K., The Interstate Fdry Co., Cleveland.
Barker, Fred, Coe Mfg. Co., Painesville, Ohio.
Barnes, T. R., Barnes Mfg. Co., Mansfield, O.
Barr, J. D., Penn. Facing Mill Co., Irwin, Pa.
Barr, W. J., The Interstate Fdry., Cleveland.
Barringer, Robert R., Baltimore Railroad Specialty Co., Corning, N. Y.
Barry, D. J., Buckeye Milling Co., Cleveland.

Bartol, Geo., Gen. Mgr. The Otis Steel Co., Cleveland.
Bates, A. N., Erie Fdry. Co., Erie, Pa.
Battenfeld, Carl, Berkshire Mfg. Co., Cleveland.
Battenfeld, J. N., Berkshire Mfg. Co., Cleveland.
Bauman, J. A., Jones & Laughlin Steel Co., Pittsburg, Pa.
Baumgardner, P. M., Holland Linseed Oil Co., Chicago, Ill.
Beach, Edward W., Manufacturers Fdry Co., Waterbury, Conn.
Beaman, J. W., W. E. Pratt, Joliet, Ill.
Beemer, Miles W., Beacon Fdry & Eng. Co., New York City.
Beers, Wm. R., Detroit Fdry. Supply Co., Detroit, Mich.
Beeson, T. S., The Wm. Tod Co., Youngstown, Ohio.
Bennett, Geo. G., The Bennett Eng. & Steam Specialty Co., Cleveland.
Bennett, H. M., *The Southern Machinist*, Atlanta, Ga.
Berchtold, L. J., Erie Eng. Co., Erie, Pa.
Bergman, Aug., The Ohio Cultivator Co., Bellevue, Ohio.
Bernard, L., Palmers & DeMooy, Cleveland.
Bever, J. J., Otis Steel Co., Cleveland.
Bill, H. L., Dodge Mfg. Co., Mishawaka, Ind.
Bixler, R. E., Buckeye Sand Co., Pittsburg, Pa.
Blanchard, A. S., The Wellman-Seaver-Morgan Co., Cleveland.
Blanchfield, C. O'D., *Industrial World*, Pittsburg, Pa.
Blunt, L. G., The Ferro Machine & Fdry. Co., Cleveland.
Blyth, Robert, Walker-Pratt Mfg. Co., Watertown, Mass.
Bocking, Ferdinand, Seerbrucken, Germany.
Boggis, H. J., Taylor & Boggis, Cleveland.
Bohnard, Wm., The Otis Steel Co., Cleveland.
Botham, J. B., Thos. W. Pangborn Co., New York City.
Boughton, A. L., The Standard Sand & Machine Co., Cleveland.
Boughton, H. E., Standard Sand & Machine Co., Cleveland.
Boughton, W. G., Standard Sand & Machine Co., Cleveland.
Boughton, H. G., Standard Sand & Machine Co., Cleveland.
Bowie, John, Corrigan, McKinney & Co., Cleveland.
Bowler, N. P., Bowler Fdry Co., Cleveland.
Boyd, C. A., Wellman-Seaver-Morgan Co., Cleveland.
Boyd, W., Wellman-Seaver-Morgan Co., Cleveland.
Boyle, James, Buckeye Eng. Co., Salem, Ohio.
Boynton, J. C., Palmers & DeMooy, Cleveland.
Bradley, John A., Akron, Ohio.
Brainard, J. C., Johnston & Jennings Co., Cleveland.
Brainard, S. W., Cleveland.
Brandau, Adam, Mfg. Molders' Shoes, Detroit, Mich.
Brans, Frank, Griswold Mfg. Co., Erie, Pa.
Brant, Wm. J., The Millers Products Co., Pittsburg, Pa.
Brown, Dennis, F. P. Curtiss Co., New Britain, Conn.
Brown, Frank P., Westinghouse Electric Co., Cleveland.
Brown, L. K., Interstate Sand Co., Zanesville, Ohio.
Bruce, W. C., Bruce-Meriam-Abbott Co., Cleveland.
Brunner, Fred J., S. Obermayer Co., Cincinnati, Ohio.
Bumbaugh, W. S., Monessen Fdry. & Machine Co., Monessen, Pa.
Bunsky, G. P., Stark Fdry. Co., Canton, Ohio.
Burgen, J. J., Lane Mfg. Co., Montpelier, Vt.
Burman, F. N., Shirley Radiator Co., Shirley, Ind.
Buyer, George, Barnes Mfg. Co., Mansfield, O.
Cadwell, E. W., Secy. Cincinnati Fdry. Foremen, care S. C., Tatum Co., Cincinnati, Ohio.
Cahill, M., City Fdry. Co., Cleveland.
Caley, Chas. J., Russell & Erwin Mfg. Co., New Britain, Conn.
Caley, H. S., Hart & Crouse Co., Utica, N. Y.
Calhoun, N. S., Johnston & Jennings Co., Cleveland.
Camp, George E., International Heater Co., Utica, N. Y.
Campbell, C. D., Medina Fdry., Medina, Ohio.
Campbell, J. W., Cleveland Wire Spring Co., Cleveland.
Carew, Wm. J., The Essex Fdry., Newark, N. J.
Carhart, Henry E., Canastota, N. Y.
Carleton, J. W., Union Mfg. Co., New Britain, Conn.
Carrick, F. A., The Globe Fdry. Co., Erie, Pa.
Carroll, F. A., The Foundry, Cleveland.
Carroll, J. T., W. Bingham Co., Cleveland.
Carson, L. L., American Mfg. Co., Pittsburg.
Carter, Frank, Interstate Sand Co., Cleveland.
Cauther, Dan, The Ohio Fdry. Co., Cleveland.
Chamberlain, F. H., J. D. Smith Fdry. Supply Co., Cleveland.
Chambers, W., The Garden City Sand Co., Chicago, Ill.
Chapman, E. M., W. M. Crane Co., Peekskill, N. Y.
Chappelka, A. H. E., Chisholm & Moore Mfg. Co., Cleveland.
Cheney, F. R., Berlin Mach. Wks., Beloit, Wis.
Cherrie, Jas., Friction Pulley Wks., Sandy Hill, N. Y.
Childs, E. D., Kilby Mfg. Co., Cleveland.
Clark, W. J., American Shipbuilding Co., Cleveland.
Clark, Wm., Cleveland Chaplet & Mfg. Co., Cleveland.
Clegg, R. I., Editor *Wood Craft*, Cleveland.
Clement, B. H., Erie Fdry. Co., Rochester, N. Y.
Cleve, J. M., Otis Steel Co., Cleveland.
Closshey, D. F., The Detroit Stove Co., Detroit, Mich.
Coble, D. C., A. Buch's Sons Co., Elizabethtown, Pa.
Coleman, F. A., J. D. Smith Fdry. Supply Co., Cleveland.
Coleman, W. H., B. F. Sturtevant Co., Chicago.
Comstock, W. A., Cleveland Wire Spring Co., Cleveland.
Corbin, A. F., Union Mfg. Co., New Britain, Conn.
Corse, Wm. M., Detroit Lubricator Co., Detroit, Mich.
Cox, P. J., Michigan Stove Co., Detroit, Mich.
Crabill, C. B., The Fanner Mfg. Co., Cleveland.
Craig, W. D., Canada Iron Furnace Co., Midland, Ont.
Cramer, M. L., The Snow Steam Pump Wks., Buffalo, N. Y.
Crandall, L. A., Detroit Fdry. Supply Co., Detroit, Mich.
Crawford, P. S., U. S. Graphite Co., Saginaw, Mich.
Cray, A. B., Chandler & Price, Palmyra, N. Y.
Cridland, H. C., Dayton, Ohio.
Crivil, G. F., F. B. Stevens, Detroit, Mich.
Crobaugh, Frank L., Cleveland.
Crook, A., Youngstown Sheet & Tube Co., Youngstown, Ohio.
Crosley, J., Multiple Moulding Machinery, Detroit, Mich.
Cross, C. M., Kilby Mfg. Co., Cleveland.
Cronenberger, W. A., Cleveland Chaplet & Mfg. Co., Cleveland.
Cuddy, G. S., The Enterprise Fdry. Co., Detroit, Mich.
Cullen, W. T., Frontier Iron Wks., Buffalo, N. Y.
Culver, Chester M., Murphy Iron Wks., Detroit, Mich.
Cummings, J. W., The U. S. Graphite Co., Saginaw, Mich.
Curley, Jas., Falls Rivet & Mach. Co., Cuyahoga Falls, Ohio.
Cutler, S. C., Republic Belting & Supply Co., Cleveland.
Dailey, Frank, Fdry. Foreman, Walworth Run Fdry. Co., Cleveland.
Daker, J., Hickman, Williams & Co., Cincinnati, Ohio.
Danver, J. H., Beaver, Pa.
Davies, Geo. C., Pilling & Crane, Philadelphia.

Degan, T., American Shipbuilding Co., Cleveland.
Deming, Geo. H., Smith Mfg. Co., Milwaukee, Wis.
DeMooy, Wm., Palmers & DeMooy, Cleveland.
Dempwolf, E. A., E. A. Dempwolf & Sons, York, Pa.
Densmore, R. E., Penton Publishing Co., Cleveland.
Derby, Fred, Taylor & Boggis Co., Cleveland.
Deverell, H. F., Otis Steel Co., Cleveland.
Diemer, H. M., Electric Controller & Supply Co., Cleveland.
Diller, H. E., Western Electric Co., Chicago.
Ditty, R., Buckeye Milling Co., Cleveland.
Dobson, Wm., Canastota, N. Y.
Donnelly, J. E. Jr., Lackawanna Steel Co., Buffalo.
Dopp, J. W., The Tabor Mfg. Co., Chicago.
Douglas, Ed. C., W. & B. Douglas, Middletown, Conn.
Douglass, W. L., Beaver Dam Malleable Iron Co., Beaver Dam, Wis.
Downerd, F. A., American Sand Co., Columbus, O.
Downerd, P. F., American Sand Co., Columbus, O.
Drummond, E. M., Drummond Mfg. Co., Louisville, Ky.
Dubinski, J., Mt. Vernon, O.
Dye, J. F., Newport Sand Bank Co., Newport, Ky.
Dyer, W. E., Port Huron Engine & Thresher Co., Port Huron, Mich.
Eagan, D. F., Henry E. Pridmore, Boston, Mass.
Eastwood, A. C., Electric Controller & Supply Co., Cleveland.
Ebel, G. F., Stark Foundry Co., Canton, O.
Edward, B. H., Detroit Register Co., Detroit, Mich.
Elbon, Chas., Berkshire Mfg. Co., Cleveland.
Erdman, Ed., Interstate Sand Co., Cleveland.
Ericson, C. H., Cleveland Wire Spring Co., Cleveland.
Evans, C. H., Atlas Bolt & Nut Co., Cleveland.
Evans, Jas. A., Erie Laboratory, Erie, Pa.
Evarts, S. J., Penton Publishing Co., Cleveland.
Fahey, Ed., J. S. McCormick Co., Pittsburg.
Falconer, N., Gunn Richards Co., New York City.
Farrow, E. L., Cleveland Wire Spring Co., Cleveland.
Fauver, H. W., Penton Publishing Co., Cleveland.
Fasy, J., W. W. Lindsay & Co., Philadelphia.
Feiss, Geo. J., Superior Foundry Co., Cleveland.
Ferris, H., The Arcade Mfg. Co., Freeport, Ill.
Field, H. E., Mackintosh, Hemphill & Co., Pittsburg.
Finley, M. S., J. D. Smith Foundry Supply Co., Cleveland.
Finucan, T., The Westinghouse Mfg. Co., Cleveland.
Fischer, J. E., Beaver Dam Malleable Iron Co., Beaver Dam, Wis.
Fisher, S. H., Harrisburg Foundry & Mach. Co., Harrisburg, Pa.
Fonda, W. H., Port Huron Engine & Thresher Co., Port Huron, Mich.
Foote, H. M., The A. M. Mfg. Co., Columbus, O.
Fortune, J. R., Murphy Iron Works, Detroit, Mich.
Forwell, Wm., Forwell Fdry. Co., Berlin, Ont.
Fox, M. Z., Hill & Griffith Co., Cincinnati.
Frankel, Philip, National Metal Trades Association, Cleveland.
Frankel, F., Berkshire Mfg. Co., Cleveland.
Franenheim, H. T., Herman Pneumatic Machine Co., Zelienopole, Pa.
Frohman, E. D., The S. Obermayer Co., Pittsburg.
Fromm, Frederick C., Manufacturers' Foundry Co., Waterbury, Conn.
Fuller, Beni. D., Westinghouse Elec. & Mfg. Co., Pittsburg.
Fulton, F. H., Studebaker Foundry Co., South Bend, Ind.
Furguson, Jay, The Ohio Foundry Co., Cleveland.
Gagen, Phil., The Ohio Foundry Co., Cleveland.
Gale, C. H., Penna. Malleable Co., Pittsburg.
Gamble, J. N., Western Tube Co., Kewanee, Ill.
Ganley, M., The Connersville Blower Co., Connersville, Ind.
Gardner, Geo. H., Gardner Publishing Co., Cleveland.
Garrett, James, Acme Foundry Co., Cleveland.
Gartland, T. H., The Best Foundry Co., Bedford, O.
Gartside, Wm. N., Diamond Clamp & Flask Co., Richmond, Ind.
Gaylord, E. S., J. D. Smith Foundry Supply Co., Cleveland.
Geffene, V. P., Acme Foundry Co., Cleveland.
Gerhart, H. J., Penna. Malleable Co., Pittsburg.
Gerdum, A., Walworth Run Foundry Co., Cleveland.
Giesey, V. A., Harbison-Walker Refractories Co., Pittsburg.
Gilbert, H. W., New York Central R. R., Frankfort, N. Y.
Gilbert, L. D., Frick Co., Waynesboro, Pa.
Gilmour, E. B., E. B. Gilmour Foundry Co., Jackson, Mich.
Golden, T. P., Golden Foundry & Machine Co., Columbus, Ga.
Goldrick, R., The Ohio Foundry, Cleveland.
Gomersall, Ben, The Toledo Casting & Forge Co., Toledo, O.
Good, Thomas R., W. & B. Douglas, Middletown, Conn.
Gordon, F. E., The Interstate Sand Co., Conneaut, O.
Gorman, J. W., Ridgeway Machine Tool Co., Ridgeway, Pa.
Goss, A. J., Tabor Mfg. Co., Philadelphia.
Gow, John, General Electric Co., Schenectady, N. Y.
Greenbaum, Wm., Acme Foundry Co., Cleveland, O.
Greene, J. B., Lucas Machine & Tool Co., Cleveland.
Greene, W. B., Palmers & DeMooy Co., Cleveland.
Griffin, W. H., Kilby Mfg. Co., Cleveland.
Griffiths, George H., *The Iron Trade Review*, Chicago.
Grimes, Geo. L., Detroit Stoker & Foundry Co., Detroit, Mich.
Griswold, W. A., Gray & Dudley Hardware Co., Nashville, Tenn.
Groves, S., editor *The Canadian Engineer*, Toronto, Ont.
Gruman, H. W., Interstate Foundry Co., Cleveland.
Grunau, Wm. F., Erie City Iron Works, Erie, Pa.
Guade, Edward R., Oil Well Supply Co., Oil City, Pa.
Guenther, A. M., Goldschmidt Thermit Co., New York City.
Gutsche, J. A., L. S. & M. S. R. R., Cleveland.
Haggerty, H. W., Corrigan, McKinney & Co., Cleveland.
Hall, J. H., Electric Controller & Supply Co., Cleveland.
Halsey, G. P., Erie Foundry Co., Erie, Pa.
Hamel, F., Detroit, Mich.
Hamilton, W., Newport News Ship Building Co., Newport News, Va.
Hammond, A. W., The Foundry, Cleveland.
Hardy, C. A., Whiting Foundry Equipment Co., Harvey, Ill.
Harpel, Frank T., H. M. Treadwell Co., Lebanon, Pa.
Harris, Irving, Detroit Register Co., Detroit, Mich.
Harrison, A. E., Allis-Chalmers Co., Milwaukee, Wis.
Harrison, Jos., J. D. Smith Foundry Supply Co., Cleveland.
Harrold, Mr., Crescent Machinery Co., Leetonia, O.
Hator, Lee O., Buffalo Co-operative Stove Co., Buffalo, N. Y.
Haurath, A. P., Interstate Foundry Co., Cleveland.
Hawkins, D. S., Westinghouse Mfg. Co., Cleveland.

Heaney, W., The Ohio Foundry Co., Cleveland.
Hector, F. T. D., *The Iron Trade Review*, Cleveland.
Henry, T. E., Medina Foundry Co., Medina, O.
Hepunstall, W. H., Torrance Malleable Iron Co., Troy, N. Y.
Herman, H. C., Herman Pneumatic Machine Co., Zelienople, Pa.
Herron, Chas. Jr., Herron Pump & Foundry Co., Chattanooga, Tenn.
Hessler, Geo. J., Syracuse Foundry Co., Syracuse, N. Y.
Heyl, Martin L., Herman Pneumatic Machine Co., Zelienople, Pa.
Hibbs, Alfred, The U. S. Pipe & Foundry Co., Cleveland.
Hildebrand, L. A., Wellman-Seaver-Morgan Co., Cleveland.
Hickok, Chas. N., M. A. Hanna Co., Cleveland.
Hiers, F. A., Diamond Clamp & Flask Co., Richmond, Ind.
Hill, W. H., Quincy Engine Works, Quincy, Ill.
Hill, J., Hill & Griffith, Cincinnati.
Hill, T., Quincy Engine Works, Quincy, Ill.
Hobolt, C., The Ohio Foundry Co., Cleveland.
Holmes, H. J., L. Schreiber & Sons Co., Cincinnati.
Holzapfel, Wm. J., Crescent Mfg. Co., Scottdale, Pa.
Horning, Jno., The Ohio Foundry, Cleveland.
Hosford, W. B., Dodge Mfg. Co., Mishawaka, Ind.
Hott, Peter, C. & G. Cooper Co., Mt. Vernon, O.
Hough, L. H., Wm. Dobson, Canastota, N. Y.
Housman, R., Kalamazoo, Mich.
Howard, W. B., Detroit Foundry Supply Co., Detroit, Mich.
Howell, Alfred E., Phillips & Buttorff Mfg. Co., Nashville, Tenn.
Hoyt, C. B., The Ohio Cultivator Co., Bellevue, O.
Hubbard, Geo. A., The Millers' Product Co., Chicago.
Hubbard, S. W., Rogers, Brown & Co., Cleveland.
Hulec, Frank, U. S. Bronze Co., Cleveland.
Hunt, D. Jr., Warner & Swasey, Cleveland.
Hurlbut, Emory, THE FOUNDRY, Cleveland.
Huston, R. T., Connersville Blower Co., Connersville, Ind.
Hutton, Wm. W., Advance Thresher Co., Battle Creek, Mich.
Ingalls, C. W., General Pneumatic Tool Co., Montour Falls, N. Y.
Jackson, Eugene, Wellman-Seaver-Morgan Co., Cleveland.
Jackson, Wm. W., Wellman-Seaver-Morgan Co., Cleveland.
Jacobi, Edward, Stirling Consolidated Boiler Co., Mansfield, O.
Jacobs, C. V., Osborn Mfg. Co., Cleveland.
Janke, Robt., Superior Foundry Co., Cleveland.
Jarecki, Chas., Jarecki Mfg. Co., Erie, Pa.
Jenkins, W. A., Olds Motor Works, Lansing, Mich.
Jewell, W. E., Acme Steel & Malleable Iron Co., Buffalo, N. Y.
Johnson, H. W., The Hill Clutch Co., Cleveland.
Johnston, S. T., The S. Obermayer Co., Chicago.
Jones, C. H., Rosedale Foundry & Machine Co., Allegheny, Pa.
Jones, John, Rosedale Foundry & Machine Co., Allegheny, Pa.
Kafer, C. A., Electric Controller & Supply Co., Cleveland.
Kanavel, U. E., Interstate Sand Co., Cleveland.
Karl, Geo., Berkshire Mfg. Co., Cleveland.
Kean, E. A., The Deming Co., Salem, O.
Keep, W. J., Michigan Stove Co., Detroit, Mich.
Keith, F. S., *Canadian Machinery*, Toronto, Canada.
Kelley, G. A., Chisholm & Moore Mfg. Co., Cleveland.
Kelley, W. H., Youngstown Foundry & Machine Co., Youngstown, O.
Kelly, T. P., T. P. Kelly & Co., New York.
Kellner, Wm., The Pattin Bros. Co., Marietta, O.
Kent, R. T., *The Iron Trade Review*, Cleveland.
Kerr, Wm., Chisholm & Moore Mfg. Co., Cleveland.
Kilby, D. J., Kilby Mfg. Co., Cleveland.
Kirkwood, J. W., Fanner Mfg. Co., Cleveland.
Kischel, Otto, Interstate Foundry Co., Cleveland.
Knight, Arthur, American Ship Building Co., Cleveland.
Knodle, C., *The Metal Industry*, Cincinnati.
Koontz, H. C., Interstate Sand Co., Cleveland.
Kronke, A. J., Cleveland Chaplet & Mfg. Co., Cleveland.
Lamp, Henry, Bettendorf Metal Wheel Co., Springfield, O.
Lane, Henry M., editor THE FOUNDRY, Cleveland.
Lane, J. S., Akron, O.
Langsenkamp, Wm. Jr., Langsenkamp Bros. Brass Works, Indianapolis, Ind.
Lathwood, J. A., Lathwood Foundry Co., Pittsburg, Pa.
Laubscher, Henry C., T. H. Brooks Iron Works, Cleveland.
Lauer, Wilhelm, Brebach, Germany.
Lavan, P. H., Interstate Foundry Co., Cleveland.
Lee, J. T., Dealer in Multiple Molding Machinery, Detroit, Mich.
Leland, Henry M., Cadillac Motor Car Co., Detroit, Mich.
Lewis, Wilfred, Tabor Mfg. Co., Philadelphia.
Little, J. W., Landis Tool Co., Waynesboro, Pa.
Logan, J. A., Jones & Laughlin Steel Co., Pittsburg.
Long, John, A. T. Hagen Co., Rochester, N. Y.
Lose, W. H., Iron City Sanitary Mfg. Co., Zelienople, Pa.
Loudon, Archie M., Elmira Heater & Foundry Co., Elmira, N. Y.
Lowe, C. F., The Penton Publishing Co., Cleveland.
Lumley, D. S., L. S. & M. S. Ry. Co., Elkhart, Ind.
Luther, F., Lackawanna Steel Co., Buffalo, N. Y.
Lynch, D. M., A. Buch's Sons, Elizabethtown, Pa.
Lynette, H. A., A. F. A. Exhibit Association, Cleveland.
Lyon, E. J., The Brown & Sharpe Mfg. Co., Providence, R. I.
McBrien, J. V., Western Foundry Supply Co., East St. Louis, Ill.
McCallum, Thomas B., Ball Engine Co., Erie, Pa.
McCaslin, H. J., Wellman-Seaver-Morgan Co., Cleveland.
McCoy, J. P., Baldwin Locomotive Works, Philadelphia.
McClumpha, H. E., National Car Wheel Co., Cleveland.
McCormick, J. S., J. S. McCormick Co., Pittsburg.
McDonald, R. A., Harbison Walker Refractories Co., Pittsburg.
McDonald, T. F., Monarch Engineering & Mfg. Co., Baltimore, Md.
McElvain, M., Berkshire Mfg. Co., Cleveland.
McEwen, H., A. Garrison Foundry Co., Pittsburg.
McFadden, W. H., Mackintosh, Hemphill & Co., Pittsburg.
McGlynn, J. B., City Foundry Co., Cleveland.
Mackenzie, H., American Ship Building Co., Cleveland.
McKnight, H. R., W. S. Tyler Co., Cleveland.
McLean, E., South Altoona Foundry, Altoona, Pa.
MacMeekin, J. B., Abram Cox Stove Co., Philadelphia.
McNeal, Chas. P., Garden City Sand Co., Chicago.
McQuillan, W. S., Colonial Foundry & Machine Co., South Norwalk, Conn.
McRoberts, S. A., *Industrial World*, Pittsburg.
Mack, C. F., Kilby Mfg. Co., Cleveland.

Maley, H., The City Foundry Co., Cleveland.
Malone, T. E., J. S. McCormick Co., Pittsburg.
Man, F. J., Republic Belting & Supply Co., Cleveland.
Martin, James V., Monarch Engineering & Mfg. Co., Baltimore, Md.
Martin, S. A., Penna. R. R. Co., Altoona, Pa.
Mayon, Joe, The Best Foundry Co., Bedford, O.
Mead, Wm. J., Pigott, Mead & Co., Cleveland.
Meaber, Edwin, Zelienople, Pa.
Meighan, John A., Dawson Bros. & Meighan, Pittsburg.
Melville, G. E., Tabor Mfg. Co., Philadelphia.
Melvin, Henry, Buhl Malleable Co., Detroit, Mich.
Meriam, J. B., Bowler Foundry Co., Cleveland.
Merriman, M. W., Madison Avenue Foundry Co., Cleveland.
Meyers, R. C., Stark Foundry Co., Canton, O.
Michel, Wm. J., Tarrant Foundry Co., Chicago.
Miers, Alfred, Walkerville Malleable Iron Co., Walkerville, Ont.
Millard, A. C., Taplin Rice Co., Akron, O.
Miller, B. A., Chisholm & Moore Mfg. Co., Cleveland.
Miller, Chas. J., Medina Foundry Co., Medina, O.
Miller, C. M., Superior Foundry Co., Cleveland.
Miller, H. S., Buckeye Milling Co., Cleveland.
Mills, H. E., C. E. Mills Oil Co., Syracuse, N. Y.
Mills, J., Chicago Pneumatic Tool Co., Cleveland.
Mills, J. F., Abendroth Bros., New York City.
Moore, T. H., Republic Belting & Supply Co., Cleveland.
Mohr, G. P., W. W. Sly Mfg. Co., Cleveland.
Moldenke, Dr. Richard, Sec'y. American Foundrymen's Association, Watchung, N. J.
Molder, H. M., The Best Foundry Co., Bedford, O.
Mollen, James F., The Variety Iron Works Co., Cleveland.
Montague, Geo. C., Norton Emery Wheel Co., Worcester, Mass.
Morton, James N., Monarch Engineering & Mfg. Co., Baltimore, Md.
Moody, R. C., Cleveland Wire Spring Co., Cleveland.
Moore, V. A., Chisholm & Moore Mfg. Co., Cleveland.
Morcon, J. H., Colorado Iron Works Co., Denver, Colo.
Morgan, Thos. J., Standard Sand & Mach. Co., Cleveland.
Morgan, W. J., Winton Motor Carriage Co., Cleveland.
Morrison, E. A., Fremont, O.
Mott, A. C. Jr., Abram Cox Stove Co., Philadelphia.
Mumford, E. H., The E. H. Mumford Co., Philadelphia.
Murphy, James A., Interstate Foundry Co., Cleveland.
Murphy, W. C., New Brighton, Pa.
Needham, Wm., Chicago Pneumatic Tool Co., Cleveland.
Neuert, Otto H., Kilby Mfg. Co., Cleveland.
Newmann, Philip, Interstate Foundry Co., Cleveland.
Newbold, Sidney, Tabor Mfg. Co., Philadelphia.
Nicholls, W. H., Berkshire Mfg. Co., Cleveland.
Noll, Wm., The Wm. Tod Co., Youngstown, O.
Norstrand, H. P. G., Rathbone, Sard & Co., Albany, N. Y.
Nusser, J. H., National Gear Wheel & Foundry Co., Allegheny, Pa.
Nuterzuter, C. H., Cleveland Chaplet & Mfg. Co., Cleveland.
Ober, A. M., Ober Mfg. Co., Chagrin Falls, O.
Oberhelman, Wm., Hill & Griffith Co., Cincinnati.
Oldfield, Harry, Goulds Mfg. Co., Seneca Falls, N. Y.
Olsen, C. O., Johnston & Jennings Co., Cleveland.
O'Neil, J. P., Western Foundry Co., Chicago.
O'Neill, Thos., Filer & Stowell Co., Milwaukee, Wis.
Ormrod, J. D., Donaldson Iron Co., Emaus, Pa.
Ott, Chas., Wellman-Seaver-Morgan Co., Cleveland.
Osborn, J. W., Walworth Run Foundry Co., Cleveland.
Paehlke, Otto F., Allyne Brass Foundry Co., Cleveland.
Parry, Wm. H., National Meter Co., Brooklyn, N. Y.
Pattin, W. S., The Pattin Bros. Co., Marietta, O.
Paul, Richard, Medina Foundry Co., Medina, O.
Peebles, R. R., Turner, Vaughan & Taylor Co., Cuyahoga Falls, O.
Penton, John A., Cleveland.
Perkins, F. N., Arcade Mfg. Co., Freeport, Ill.
Perrine, W. A., Abram Cox Stove Co., Philadelphia.
Peters, M. W., Madison Avenue Foundry Co., Cleveland.
Pickands, J. M., Pickands, Mather & Co., Cleveland.
Pickup, G. E., Wehrle Stove Co., Newark, O.
Pigott, Thomas E., Pigott, Mead & Co., Cleveland.
Pinney, H. H., Westinghouse Elec. & Mfg. Co., Cleveland.
Power, R. E., editor *Boating*, Cleveland.
Price, W. A., Berkshire Mfg. Co., Cleveland.
Pridmore, E. A., Henry E. Pridmore, Chicago.
Pridmore, H. A., Henry E. Pridmore, Chicago.
Pridmore, Henry E., Chicago.
Putnam, W. P., Detroit Testing Laboratory, Detroit, Mich.
Quinn, Hugh T., Eaton, Cole & Burnham Co., Bridgeport, Conn.
Radigan, J. E., Interstate Foundry Co., Cleveland.
Ramp, H. M., General Electric Co., Schenectady N. Y.
Ramp, P. R., Murray Iron Works Co., West Burlington, Ia.
Ranney, H. P., American Ship Building Co., Cleveland.
Rathbone, J. A., Detroit, Mich.
Rath, C. J., The Fulton Foundry, Cleveland.
Reddington, P., Silver Mfg. Co., Salem, O.
Redmond, Geo. F., Interstate Foundry Co., Cleveland.
Reese, John, Falls Rivet & Machine Co., Cuyahoga Falls, O.
Reid, D., Canadian Westinghouse Co., Hamilton, Ont.
Reilly, James, Westinghouse Mfg. Co., Cleveland.
Richardson, W. G., Allis Chalmers Co., Milwaukee, Wis.
Riddell, W. A., Sharon Foundry Co., Sharon, Pa.
Ring, R. H., Cortlandt Corundum Wheel Co., Cortlandt, N. Y.
Roche, Thos., National Car Wheel Co., Cleveland.
Rodgers, J. A., Western Foundry Supply Co., East St. Louis, Ill.
Roedell, Wm. A., Kennedy Valve & Mfg. Co., Coxsackie, N. Y.
Roseberry, W. J., Municipal Engineering & Contracting Co., Cleveland.
Ross, J. W., Landis Tool Co., Waynesboro, Pa.
Rouse, R., The Boynton Furnace Co., Jersey City, N. J.
Ruthenberg, Gus, Allyne Brass Foundry Co., Cleveland.
Rutson, W., Buckeye Sand Co., Pittsburg.
Ryan, D. J., Interstate Foundry Co., Cleveland.
Sands, James, Superior Foundry Co., Cleveland.
Sargent, W. P., Niles Tool Works, Hamilton, O.
Saveland, Harry, Acme Foundry Co., Cleveland.
Scheel, M. J., The W. S. Tyler Co., Cleveland.
Scheen, D. J., Interstate Foundry Co., Cleveland.
Schilling, Joseph, Russell & Erwin Mfg. Co., New Britain, Conn.
Schlichte, George, Falls Rivet & Mach. Co., Cuyahoga Falls, O.

Schoenberger, W. J., United Brass Co., Cleveland.
Schowe, H. G., Bowler Foundry Co., Cleveland.
Schreiber, Wm. A., Schreiber & Sons Co., Cincinnati.
Schwab, J., Skinner Engine Co., Erie, Pa.
Schwarzenberg, H. L., Waterbury Crucible Co., Cleveland.
Schwoerer, F. C., Acme Foundry Co., Cleveland.
Scofield, Lane, The Tabor Mfg. Co., Philadelphia.
Scott, Arthur, Cleveland Pneumatic Tool Co., Cleveland.
Scoville, F. S., C. E. Mills Oil Co., Syracuse, N. Y.
Seaman, J. S., Seaman-Sleeth Co., Pittsburg.
Seedhouse, Edwin, Falls Rivet & Machine Co., Cuyahoga Falls, O.
Seelbach, Charles, Forest City Foundry, Cleveland.
Seidler, Wm., Jarecki Mfg. Co., Erie, Pa.
Shaver, G. N., Crystal Fluor Spar Mining Co., Cleveland.
Shed, N. W., The Buffalo Foundry Co., Buffalo, N. Y.
Shennan, W. J., Bethlehem Steel Co., Bethlehem, Pa.
Sherwin, Edward J., Wellman-Seaver-Morgan Co., Akron, O.
Sherwood, Chas., Republic Belting & Supply Co., Cleveland.
Sinclair, D. G., Illinois Steel Co., South Chicago, Ill.
Skiff, Warner, Westinghouse Electric & Mfg. Co., Pittsburg.
Skully, W. C., Smith & Anthony Co., Boston, Mass.
Sleeth, S. D., Westinghouse Air Brake Co., Pittsburg, Pa.
Slocum, A. W., Dickson Car Wheel Co., Houston, Texas.
Sly, W. C., Sly Mfg. Co., Cleveland.
Sly, W. W., Sly Mfg. Co., Cleveland.
Smart, George Editor *The Iron Trade Review*, Cleveland.
Smith, C. T., Chicago Pneumatic Tool Co., Cleveland.
Smith, F. G., Osborn Mfg. Co., Cleveland.
Smith, F. N., S. R. Dresser Mfg. Co., Bradford, Pa.
Smith, J. S., J. D. Smith Foundry Supply Co., Cleveland.
Smith, P. C., Ingersoll-Rand Co., Phillipsburg, N. J.
Smith, P. G., J. D. Smith Foundry Supply Co., Cleveland.
Smith, Wm., Standard Sand & Machine Co., Cleveland.
Smith, W. H., Standard Sand & Machine Co., Cleveland.
Somerwill, W. J., Palmers & DeMooy Foundry Co., Cleveland.
Southcourt, H. P., Holland Linseed Oil Co., Chicago.
Sords, J. F., Interstate Foundry Co., Cleveland.
Stadelman, W. A., Wellman-Seaver-Morgan Co., Cleveland.
Starcher, J. H., William Dobson, Pittsburg.
Steinfurth, J. C., Cascade Foundry Co., Erie, Pa.
Stephenson, B. S., *The Iron Trade Review*, Cleveland.
Stevens, Frederic B., Detroit, Mich.
Stoddard, J. D., The Detroit Testing Co., Detroit, Mich.
Stone, Bert, Walworth Run Foundry Co., Cleveland.
Stone, H. H., Penna. R. R., Altoona, Pa.
Strangward, Wm., Forest City Foundry Co., Cleveland.
Strangward, P., Forest City Foundry Co., Cleveland.
Stratton, Dr. S. W., Director National Bureau of Standards, Washington, D. C.
Strehler, Alfred, Clemens Const. Co., Cleveland.
Streich, E. F., Osborn Mfg. Co., Cleveland.
Stutz, Ernest, Goldschmidt Thermit Co., New York.
Sweeney, A. J., Corrigan, McKinney & Co., Cleveland.
Sweeney, M. J., Interstate Sand Co., Cleveland.
Swift, Chas. C., City Foundry Co., Cleveland.
Ten Winkel, W. A., Electric Controller & Supply Co., Cleveland.
Thompson, W. R., Interstate Sand Co., Detroit, Mich.
Thomas, D. J., Sterritt Thomas Foundry Co., Pittsburg.
Thorner, Justus, The S. Obermayer Co., Cincinnati.
Thrasher, G. M. Jr., Western Tube Co., Kewanee, Ill.
Tidball, R., Buckeye Milling Co., Cleveland.
Tingle, A. R., The American Sand Co., Columbus, O.
Titus, T., Titus Foundry, Coldwater, Mich.
Tobien, R. C., The Ohio Foundry Co., Cleveland.
Tolmie, R. C., Lobdell Car Wheel Co., Wilmington, Del.
Towns, F. J., Pittsburg Valve & Fittings Co., Pittsburg.
Towers, J. F., Tenn. Coal, Iron & R. R. Co., Birmingham, Ala.
Trabue, W. D., Phillips & Buttorff Mfg. Co., Nashville, Tenn.
Trenkamp, John, The Ohio Foundry Co., Cleveland.
Troegele, Chas., Walworth Run Foundry Co., Cleveland.
Troy, Andy, The Interstate Foundry Co., Cleveland.
Turnney, P. J. F., Turnney Copper & Bronze Co., Cleveland.
Turnbull, R. E., Henry E. Pridmore, Chicago.
Urwin, J. W., Massillon Sand & Stone Co., Massillon, O.
Vetterlein, John, Chisholm & Moore Mfg. Co., Cleveland.
Wadsworth, J. L., The Penton Publishing Co., Cleveland.
Wadsworth, Geo. W., Falls Rivet & Machine Co., Cuyahoga Falls, O.
Wainwright, W., Falls Rivet & Machine Co., Cuyahoga Falls, O.
Waite, Geo. E., Ober Mfg. Co., Chagrin Falls, O.
Waite, Geo. W., Friction Pulley & Machine Works, Sandy Hill, N. Y.
Wagner, L. G., Acme Foundry Co., Cleveland.
Walda, Wm. C., Central Foundry Co., Fort Wayne, Ind.
Wales, A., Russell Engine Co., Massillon, O.
Wallis, W. R., *The American Machinist*, New York City.
Walton, Geo., Madison Avenue Foundry Co., Cleveland.
Wathey, Arthur, Allyne Brass Co., Cleveland.
Wathey, T., Macbeth Iron Co., Cleveland.
Watters, J., Western Foundry Co., Chicago.
Weaver, George H., Dominion Foundry & Supply Co., Montreal, Can.
Webb, J. F., L. S. & M. S. R. R., Elkhart, Ind.
Webster, J. R., C. E. Mills Oil Co., Syracuse, N. Y.
Webster, J. H., Buckeye Milling Co., Cleveland.
Wegat, Art., The Ohio Foundry, Cleveland.
Weidler, E. V., Oil Well Supply Co., Oil City, Pa.
Weirich, S. R., Myers & Gardner, Massillon, O.
Wennick, A. B., Walworth Run Foundry Co., Cleveland.
West, Ralph D., Cleveland.
West, Thos. D., Pres. American Foundrymen's Association, Sharpsville, Pa.
White, Frank C., White Tool & Supply Co., Cleveland.
White, J., C. H. & D. R. R., Lima, O.
Wieman, Wm., Robert Field Sales Agency, Pittsburg.
Wilkins, Geo. W., The Erie Foundry Co., Erie, Pa.
Wilkinson, S., Abendroth & Root, Newburg, N. Y.
William, A. T., Enterprise Mfg. Co., Philadelphia.
Williams, R. D., *The Marine Review*, Cleveland.
Williams, L. A. Jr., Atlas Car & Mfg. Co., Cleveland.
Wilson, H., Rogers, Brown & Co., Cleveland.

XUM

SOME OF THE SOUVENIRS.

Wilson, J. J., The Cadillac Motor Car Co., Detroit, Mich.
Wilson, Wm. M., Frederic B. Stevens, Detroit, Mich.
Winlock, J. P., Barbour-Stockwell Co., Cambridge, Mass.
Wooden, P. M., Reeves & Co., Columbus, Ind.
Woodison, E. J., Detroit Foundry Supply Co., Detroit, Mich.
Wright, W. B., Youngstown, O.
Wright, Henry, Otis Elevator Co., Cleveland.
Yagle, Wm., Yagle Mfg. Co., Pittsburg.
York, R. H., Berkshire Mfg. Co., Cleveland.
Young, J., Penna R. R., Altoona, Pa.
Zilles, P. C., Wellman-Seaver-Morgan Co., Cleveland.
Zimmers, F. H., Union Foundry & Machine Co., Pittsburg.

CONVENTION SOUVENIRS.

The convention this year was marked by an unusually fine line of souvenirs. The Osborn Mfg. Co., of Cleveland, gave a box containing a clothes brush. On the back of the brush was the advertisement of the Osborn Mfg. Co., maker of foundry supplies, Economy wire wheels, and all kinds of brushes for foundry and platers' use. Upon the outside of the box was a statement that the brush was given at the convention of the American Foundrymen's Association, June, 1906.

The Hill & Griffith Co., of Cincinnati, O., gave a very pretty metal plaque, with a picture of a girl surrounded by a border of lilies upon it. The plaque was arranged to be supported in a vertical position in a wire holder.

E. A. Dempwolf & Sons, of York, Pa., presented the members with a numerical mind reader for telling anyone's age, which consisted of a number of cards cut in such a way that when the ones containing the age were properly assembled the age could be read upon the face.

The Interstate Sand Co., of Cleveland, gave away two souvenirs, one of which was a pocket book with a long pocket for bills and several small pockets for cards, and also a leather match safe with a small pocket for street car tickets and a piece of sand paper protected by a leather flap.

The C. E. Mills Oil Co., of Syracuse, N. Y., gave away the most striking novelty of the convention in the form of a trick match box, which was so arranged with a false bottom and lock that when in one position it would open so as to show the matches and in another position would show only an empty box. Upon the outside of the box was printed. "You cannot find a match for Mills' No. 1 and No. 2 Dry Core Compound, or Syracuse X-XX-XXX core oil."

The W. W. Lindsay Mfg. Co., of Philadelphia, gave a very neat paper weight in the shape of a tinned chaplet with the firm's name stamped on the head.

"Uncle Billy," of the Garden City Sand Co., Chicago, presented his friends with a fountain pen, which was appreciated by all the recipients.

Mr. Chas. J. Caley, of the Russell & Erwin Mfg. Co., New Britain, Conn., presented the ladies of the party on the day of the boat ride with a very pretty bronze souvenir paper cutter, which was presented in a box lined with plush.

The Standard Sand & Machine Co., of Cleveland, made those who visited this exhibit happy by presenting them with a neat little wallet for change.

Knowing the propensities of many of the foundrymen for forgetting their location after an evening's pleasure, Jimmie Smith, of the J. D. Smith Foundry Supply Co., Cleveland, selected as a suitable gift for his friends an initial watch fob which was very neatly gotten up. Upon the front there is an enameled initial letter of the receiver and on the back the statement that it is presented with the compliments of the J. D. Smith Foundry Supply Co.

The Western Foundry Supply Co., of East St. Louis, Ill., gave sample bags containing ground 80 per cent ferro-manganese, each sample being enough for a fair trial in a small ladle of iron.

The Berkshire Mfg. Co., Cleveland, had prepared and cast a series of paper weights which were molded on the Berkshire machine. Upon the upper face of the paper weight is a relief picture of the Berkshire molding machine.

XUM

The Norton Emery Wheel Co., of Worcester, Mass., presented a leather match safe with a place for striking the matches under the flap.

Wm. Dobson, of Canastota, N. Y., manufacturer of molders' tools, distributed a six-inch aluminum rule with his advertisement stamped upon it.

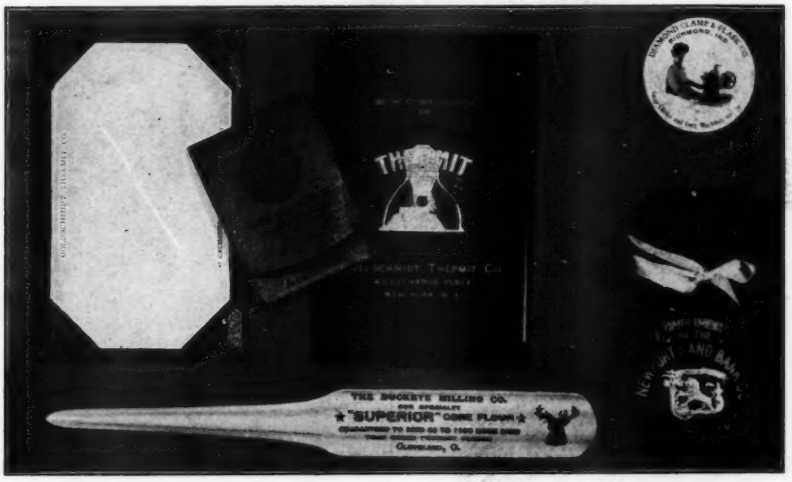
Some of the most important gifts, however, were along the smoking line. The W. W. Sly Mfg. Co., of Cleveland, presented its friends with an aluminum cigar case, containing three good smokes.

The Falls Rivet & Machine Co., of

The U. S. Graphite Co., of Saginaw, Mich., distributed pencils made from its Mexican mine graphite.

The Buckeye Milling Co., Cleveland, O., distributed pound bags of Wago core compound and also large wall calendars.

Henry E. Pridmore, Chicago, manufacturer of the "Pridmore" molding machines, is known for the handsome souvenirs he distributes at the conventions of the American Foundrymen's Association. This year, his remembrance is a most useful one from a man's standpoint. It is a beautiful



A FEW OF THE SOUVENIRS.

Cuyahoga Falls, O., presented all of the members at the smoker with a cigar pouch containing four first-class cigars. Upon the front of the case was the statement: "These sample cores were made on the Wadsworth improved core machine by the Falls Rivet & Machine Co., engineers, machinists and founders, of Cuyahoga Falls, O."

The Chicago Pneumatic Tool Co. presented the guests at the smoker with a high-grade corn cob pipe, while the local committee handed out a souvenir bag of tobacco, a souvenir beer stein and cigars banded with A. F. A. and A. F. F.

French briar pipe, with amber mouthpiece. The bowl is highly polished, the rim and neck being surrounded with solid gold bands. It is a costly gift, and one that will be highly appreciated by every recipient. It is not a large pipe, nor a heavy one, and it can be held in the mouth or carried in the pocket without any inconvenience to the user. A leather case goes with each pipe.

The Goldschmidt Thermit Co., of New York city, distributed a memorandum pad which was bound in leather and contained sheets of paper for memoranda which were secured by

the corners as shown in the accompanying illustration.

The Diamond Clamp & Flask Co., of Richmond, Ind., distributed a looking glass in a celluloid frame, upon the back of which there was a picture of Mr. Gartside's new Universal core machine, being operated by a pretty girl.

J. Frank Dye, of the Newport Sand Bank Co., of Newport, Ky., left a sweet memory behind him by distributing small sachet bags. He said that they were guaranteed to always smell just as sweet, provided you kept enough perfumery in them.

The Buckeye Milling Co., of Cleveland, distributed a celluloid envelope opener, with an advertisement of the Superior core flour printed upon the back.

In this connection we cannot help but call attention to the fact that bringing the entertainment features of the convention into the hands of the newly formed supply men's association will have a tendency to reduce the grabbing of souvenirs by parties who have no right to them and of repeating on the part of many of the souvenir hunters. This matter, however, is mentioned more fully in another part of this issue.

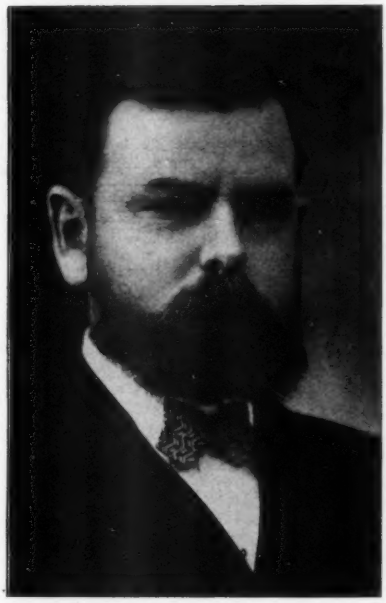
W. H. McFADDEN, PRESIDENT OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION.

W. H. McFadden, newly elected president of the American Foundrymen's Association, is one of the best known and most popular manufacturers in the country. He is vice president and general manager of Mackintosh, Hemphill & Co., of Pittsburg, and his entire career in the iron and steel business has been in connection with this company.

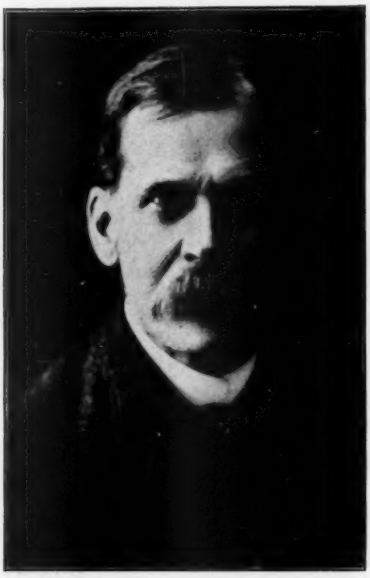
Mr. McFadden is a self-made man, who, by native ability and steady application, advanced himself from machinist apprentice to general manager of one of the largest concerns of its kind in the country. For many years he has been actively identified with the National Founders' Association as chairman of the third district and has served on its administrative council and assisted in this capacity in concluding successfully many of its most important conferences between that association and the molders' union. He was also president of the Pittsburg Manufacturers' Association in 1905 and president of the Pittsburg Foundrymen's Association the same year. Under Mr. McFadden's supervision, machinery for the following plants was built and erected: Ashland Steel Co., Bellaire Steel Co., Benwood Steel

W. H. MCFADDEN, PRESIDENT THE A. F. A.

Works, Bethlehem Steel Co., Colorado Fuel & Iron Co., Duquesne Steel Works, Edgar Thomson Steel Works, Jefferson Iron Works, Hainsworth Steel Co., Homestead Steel Works, Jones & Laughlin Steel Co., Junction Steel & Iron Co., Joliet Steel Works, King, Gilbert & Warner Co., Troy Steel Co., Lackawanna Steel Co., Maryland Steel Co., National Tube Co., and its different plants, Passaic Rolling Mill Co., Phoenix Iron Co., Eastern Steel Co., Park Brothers & Co., Portsmouth Steel Co., Riverside Iron Works, Roane Iron Co., Spang, Chalfant &



C. J. CALEY, VICE PRESIDENT THE FIRST DISTRICT.



W. J. KEEP, VICE PRESIDENT THE FIFTH DISTRICT.

Co., Schoenberger Steel Co., Shenango Valley Steel Co., Cambria Steel Co., Dominion Iron & Steel Co., Worcester Steel Works, New York State Steel Co., Youngstown Sheet & Tube Co. and Millikin Bros.

In April, 1888, Mr. McFadden

JOHN W. BURR, VICE PRESIDENT THE SECOND DISTRICT.

JOHN HILL WHITING, VICE PRESIDENT THE FOURTH DISTRICT.

started as a general apprentice in the machine shop and drawing room of Mackintosh, Hemphill & Co., Ltd., pattern shop. Eager to master his and served time in the foundry and chosen profession, Mr. McFadden, by over time and Sunday work, served one year and five months additional apprenticeship, or during his three years' term by this means served four years and five months. In 1891, before he had finished his apprenticeship, Mr. McFadden was sent by his company to

L. L. ANTHES, VICE PRESIDENT THE EIGHTH DISTRICT.

superintend the construction of the Ashland Steel Co.'s plant at Ashland, Ky., and in 1892, returned and finished his time in the shops.

In 1893, he was made foreman of the open-hearth steel department of Mackintosh, Hemphill & Co., Ltd., and held this position one year, when, in 1894, he was made general superintendent of the whole plant. In 1895, while acting as superintendent of the plant, he assumed the additional duties of superintending the building of the Star tin plate plant, including both buildings and machinery. In 1896, Mr. McFadden was made assistant manager of Mackintosh, Hemphill & Co., and held this position until 1902, when, under the partial reorganization of the company, and the retirement of Mr. Hemphill, he was made vice president and general manager, which position he still holds.

Mr. McFadden is a tireless worker and in connection with his election as president of the American Foundrymen's Association, he said he is going to put forth every effort to make this year the greatest in the history of the organization.

A PLEA FOR LOWER BLAST PRESSURES IN CUPOLA AND AIR FURNACES.

BY WILLIAM H. COLEMAN, CHICAGO, ILL.

Within the remembrance of our older foundrymen there was a time when blast pressures of 22 to 24 ounces at the wind box and in the supply pipe to the cupola were deemed necessary to melt iron and to make good castings. Although considerable changes have been made, tending to increase the capacity and economy of cupola practice, yet some foundrymen adhere to what may be termed high blast pressures.

Modern practice calls for greater height of charging doors from bottom of cupola, larger wind box and greater tuyere area, together with larger pipe for air supply. Formerly where coal was used in cupolas, the fuel ratios predominating were as high as six and five to one, and the total tuyere area ranged down to as low as 10 per cent of the area of the cross section of the inside lining of the cupola.

In those days even with the high blast pressures then used, clogging of the tuyeres was quite commonly observed. In a cupola of 48-inch diameter inside the lining, we would have a cross section of 1809.56 inches. The area of the tuyeres would equal about seven per cent of this or 126.66 square inches. In order to force the required amount of air through this restricted area, a comparatively high pressure of at least 16 to 18 ounces was required, but by doubling this tuyere area either by putting in more tuyeres or having them larger, up to 20 or

even 25 per cent of the cross section of the inside diameter of cupola, a lower blast pressure can be used, the volume of air remaining the same. Table No. 1 clearly indicates the rapid increase in friction resulting from higher velocities. It is a convincing argument in favor of large areas and low velocities. This table is from a catalog of the B. F. Sturtevant Co., and is for pipes 100 feet long.

In order to get a large volume of air through restricted tuyere area the blast pressures must be correspondingly high. The prominent cupola builders recognize that enlarged tuyere area is an advantage, but some of them continue to recommend higher blast pressures than are commonly used among the best informed cupola managers. The substitution of coke for coal, as a fuel, seems to make larger volumes of air necessary, and the soft by-product coke, while having the properties of an ideal cupola fuel, must be mixed with the harder cokes, and requires more oxygen than the hard cokes of the east, and therefore more air to make it melt iron rapidly.

Recent changes in methods of charging the cupola, and the better attention which the makers have given to teaching foundrymen how to use by-product coke have brought about better fuel ratios and other improved conditions.

TABLE NO II.

Type.	R. P. M.	Dia. Wheel.	Pressure. Ounces.	Air per min. cubic feet.	H. P.
Sturtevant Steel Pressure Blower.....	1,618	41-¼ in.	12	3,760	20.5
Sturtevant "Monogram" Blower.....	780	40 in.	2.5	10,600	12.0

It is now undoubtedly the best practice to use lower blast pressures to such a point as the consequent lower capacity will admit of. It is, of course, agreed that if capacity only is to be considered, then the higher blast pressure must be employed.

High and Low Blast Pressures for Air Furnaces.

In speaking of this subject here I do so for the reason that many members of this association operate both the cupola and the air furnace. I find the air furnace operators are greater sinners in regard to high blast pressures than the cupola men.

The correct volume and blast pressure for air furnace work depends upon the rate of coal consumption on the grate per square foot per hour and the quality of coal used. Heed should be paid to whether the coal is heaped high on the grate and whether or not the furnace is crowded.

The air supply pipes under the grates and those for the top blast should be of ample size and fitted without abrupt curves or elbows. In this way low blast pressures may be utilized, and consequently considerable power may be saved, as is shown in the following table which compares the steel pressure blower having small volumetric capacity, with the low pressure fan having large capacity at a lower pressure.

It is quite evident that the low pressure type of fan is the more economical for air furnace work.

I believe that in an air furnace under proper working conditions there is little reason for the down blast through small thimbles to support combustion where the volumes and velocities of the air under the grates are proportionally arranged. If the thimbles are enlarged up to at least three inches diameter in the eight-ton furnace, and at least four inches diameter in the ten-ton furnace and are fitted to a supply pipe with a funnel or gradual taper, and if they are of sufficient number, they will offer very little frictional resistance to the air. If all these conditions are fully met there will cease to be any reason for high velocities or high pressures of air in this type of furnace. You can blow more of a flame down by four thimbles of 3-inch diameter at two ounces pressure than with five thimbles of 1½-inch diameter at six ounces pressure because the combined thimble or tuyere area is greater.

To pass 100 cubic feet of air per minute through a pipe whose diameter is 2½ inches, requires an air velocity of

TABLE NO. 1.

PRESSURE AND HORSEPOWER LOST BY FRICTION OF AIR IN PIPES 100 FEET LONG.

Velocity of Air in Feet per Minute.	DIAMETER OF PIPE.																					
	11-inch.		12-inch.		13-inch.		14-inch.		16-inch.		18-inch.		20-inch.		22-inch.		24-inch.		26-inch.	
	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss.of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.	Loss of Press. in oz. per sq. in.	H. P. lost in Friction.
100	0.001	0.0000	0.001	0.0000	0.001	0.0000	0.001	0.0000	0.001	0.0000	0.001	0.0000	0.001	0.0000	0.001	0.0000	0.000	0.0000	0.000	0.0000
200	0.004	0.0001	0.004	0.0002	0.003	0.0002	0.003	0.0002	0.003	0.0002	0.002	0.0002	0.002	0.0003	0.002	0.0003	0.002	0.0003	0.002	0.0003
300	0.009	0.0005	0.008	0.0005	0.008	0.0006	0.007	0.0006	0.006	0.0007	0.006	0.0008	0.005	0.0009	0.005	0.0010	0.004	0.0011	0.004	0.0012
400	0.016	0.0012	0.015	0.0013	0.014	0.0014	0.013	0.0015	0.011	0.0017	0.010	0.0019	0.009	0.0021	0.008	0.0023	0.007	0.0025	0.007	0.0027
500	0.025	0.0023	0.023	0.0025	0.021	0.0027	0.020	0.0029	0.017	0.0033	0.016	0.0037	0.014	0.0041	0.013	0.0045	0.012	0.0050	0.011	0.0054
600	0.036	0.0039	0.033	0.0043	0.031	0.0046	0.029	0.0050	0.025	0.0057	0.022	0.0064	0.020	0.0071	0.018	0.0079	0.017	0.0086	0.015	0.0093
700	0.049	0.0062	0.045	0.0068	0.041	0.0074	0.039	0.0079	0.034	0.0091	0.030	0.0102	0.027	0.0113	0.025	0.0125	0.023	0.0136	0.021	0.0147
800	0.064	0.0093	0.059	0.0102	0.055	0.0109	0.051	0.0118	0.044	0.0135	0.040	0.0152	0.036	0.0169	0.032	0.0186	0.029	0.0203	0.027	0.0220
900	0.081	0.0132	0.075	0.0145	0.069	0.0157	0.064	0.0169	0.056	0.0193	0.050	0.0217	0.045	0.0241	0.041	0.0265	0.037	0.0289	0.035	0.0313
1,000	0.101	0.0182	0.092	0.0198	0.085	0.0215	0.079	0.0231	0.069	0.0264	0.062	0.0297	0.056	0.0330	0.051	0.0364	0.046	0.0397	0.043	0.0430
1,100	0.122	0.0242	0.112	0.0264	0.103	0.0286	0.096	0.0308	0.084	0.0352	0.075	0.0396	0.067	0.0440	0.061	0.0484	0.056	0.0528	0.052	0.0572
1,200	0.145	0.0314	0.133	0.0343	0.123	0.0371	0.114	0.0400	0.100	0.0457	0.089	0.0512	0.080	0.0571	0.073	0.0628	0.067	0.0685	0.062	0.0742
1,300	0.170	0.0399	0.156	0.0437	0.144	0.0472	0.134	0.0508	0.117	0.0581	0.104	0.0654	0.094	0.0726	0.085	0.0799	0.078	0.0873	0.072	0.0944
1,400	0.198	0.0499	0.181	0.0544	0.167	0.0589	0.156	0.0635	0.136	0.0726	0.121	0.0816	0.109	0.0907	0.099	0.0998	0.091	0.1088	0.084	0.1179
1,500	0.227	0.0613	0.208	0.0669	0.192	0.0725	0.179	0.0781	0.156	0.0892	0.139	0.1004	0.125	0.1115	0.114	0.1227	0.104	0.1339	0.096	0.1450
1,600	0.259	0.0735	0.237	0.0812	0.219	0.0880	0.203	0.0948	0.178	0.1083	0.158	0.1218	0.142	0.1354	0.129	0.1469	0.119	0.1624	0.109	0.1760
1,700	0.292	0.0893	0.268	0.0974	0.247	0.1055	0.229	0.1137	0.207	0.1299	0.178	0.1461	0.161	0.1624	0.146	0.1786	0.134	0.1948	0.124	0.2110
1,800	0.327	0.1060	0.300	0.1156	0.278	0.1253	0.257	0.1351	0.225	0.1542	0.200	0.1735	0.180	0.1927	0.164	0.2120	0.150	0.2313	0.139	0.2506
1,900	0.365	0.1247	0.334	0.1360	0.308	0.1472	0.287	0.1587	0.251	0.1814	0.223	0.2040	0.201	0.2267	0.182	0.2494	0.167	0.2720	0.154	0.2945
2,000	0.404	0.1454	0.370	0.1586	0.341	0.1719	0.317	0.1851	0.278	0.2115	0.247	0.2380	0.222	0.2644	0.202	0.2908	0.185	0.3173	0.171	0.3437
2,200	0.489	0.1936	0.448	0.2111	0.413	0.2287	0.384	0.2463	0.336	0.2815	0.299	0.3167	0.269	0.3519	0.244	0.3871	0.224	0.4223	0.207	0.4575
2,400	0.582	0.2513	0.533	0.2741	0.492	0.2970	0.457	0.3198	0.400	0.3455	0.356	0.4112	0.320	0.4569	0.291	0.5026	0.267	0.5483	0.246	0.5939
2,600	0.683	0.3195	0.626	0.3485	0.578	0.3776	0.537	0.4066	0.468	0.4647	0.417	0.5228	0.376	0.5809	0.341	0.6390	0.313	0.6971	0.289	0.7552
2,800	0.792	0.3990	0.726	0.4353	0.670	0.4716	0.622	0.5079	0.544	0.5804	0.484	0.6530	0.436	0.7255	0.396	0.7981	0.363	0.8706	0.335	0.9432
3,000	0.909	0.4908	0.833	0.5354	0.769	0.5800	0.714	0.6245	0.625	0.7140	0.556	0.8031	0.500	0.8923	0.455	0.9816	0.417	1.0708	0.385	1.1601
3,200	1.034	0.5956	0.948	0.6498	0.875	0.7039	0.813	0.7581	0.711	0.8664	0.632	0.9747	0.569	1.0830	0.517	1.1913	0.474	1.2996	0.438	1.4079
3,400	1.168	0.7144	1.070	0.7794	0.988	0.8441	0.917	0.9093	0.827	1.0475	0.714	1.1690	0.642	1.2990	0.584	1.4289	0.535	1.5588	0.494	1.6882
3,600	1.309	0.8481	1.200	0.9252	1.114	1.0023	1.029	1.0800	0.900	1.2335	0.800	1.4078	0.720	1.5420	0.655	1.6962	0.600	1.8504	0.557	2.0046
3,800	1.459	0.9974	1.337	1.0871	1.234	1.1880	1.146	1.2695	1.003	1.4508	0.891	1.6342	0.802	1.8135	0.729	1.9949	0.669	2.1742	0.617	2.3760
4,000	1.616	1.1734	1.481	1.2691	1.367	1.3749	1.270	1.4807	1.111	1.6922	0.988	1.9037	0.889	2.1152	0.808	2.3467	0.741	2.5382	0.684	2.7498
4,200	1.782	1.3667	1.633	1.4692	1.508	1.5916	1.400	1.7140	1.225	1.9589	1.089	2.2037	0.980	2.4486	0.891	2.7335	0.817	2.9383	0.754	3.1832
4,400	1.946	1.5484	1.784	1.6892	1.655	1.8300	1.537	1.9707	1.344	2.2522	1.189	2.5338	1.071	2.8153	0.973	3.0969	0.892	3.3784	0.827	3.6599
4,800	2.327	2.0103	2.133	2.1930	1.969	2.3758	1.829	2.5585	1.600	2.9241	1.422	3.2896	1.280	3.6551	1.164	4.0206	1.067	4.3861	0.985	4.7516
5,200	2.731	2.5559	2.504	2.7882	2.311	3.0206	2.146	3.2530	1.871	3.7177	1.670	4.1824	1.502	4.6471	1.366	5.1118	1.252	5.5765	1.156	6.0412
5,600	3.168	3.1923	2.904	3.4825	2.680	3.7727	2.489	4.0629	2.178	4.6433	1.936	5.2237	1.742	5.8041	1.584	6.3845	1.452	6.9649	1.340	7.5453
6,000	3.636	3.9263	3.333	4.2833	3.077	4.6402	2.857	4.9959	2.500	5.7110	2.222	6.4249	2.000	7.1388	1.818	7.8527	1.667	8.5666	1.538	9.2804

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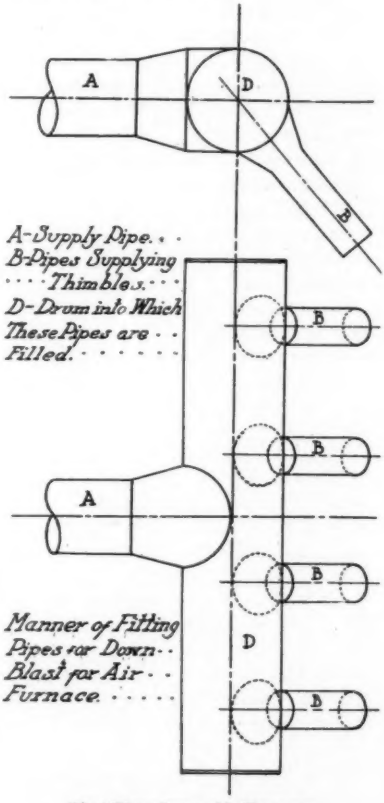
3,000 feet per minute. While through a 4-inch pipe with a velocity of 2,300 feet per minute, double the amount of air may be passed.

The experience of our fan engineers, (fan engineering is now recognized as a distinct and special line of engineering) show that 200 to 300 cubic feet of air is required to burn 1 lb. of coal, and that the pressures should be 1¾ to 2¼ ounces under the grate for air furnace work. Assume 20 to 40 pounds coal per square foot of grate and allow 15 to 25 per cent additional air for the down blast, and make openings and pipes of ample area, letting the air for down blast be supplied at same pressure as that below the grates. Under this change of conditions from high velocities of air through small thimbles, some of your air furnace tenders will complain of not getting enough pressure. Strange, they never complain of "not getting enough air." They seem to think that if the air with its high velocity rushing through the small orifices "whistles," everything is all right. Now, this is one of those "whistles" that comes high. If you must have air and plenty of it in your down blast, make your openings large and use the proper type of fan: The volume fan and not the cupola fan.

"The introduction of this down blast throws the flame over on to the iron in the bath," says our air furnace man. It seems to me that the use of this down blast at high pressure is one of the reasons why the ratio of fuel to metal is 60 per cent instead of 30 per cent, which is at least the theoretical ratio. Some of our largest makers of gray iron castings have been frightened away from using the air furnace to melt pig iron by reason of its high fuel consumption.

The air furnace is subject to great wear and tear; this can undoubtedly be lessened, as in the cupola, by using low pressures.

I am inclined to think that if there is a sufficiency of air under the grates, and if the air spaces in the grates are proportioned properly, the combustion will be all that is required. The introduction of cold air beyond the bridge wall tends to cool off the gases of combustion and interferes very materially with the draft through the stack. We know from our laboratory experiments with a Bunsen burner, in mixing gas and air for a heating flame, that cold air will not mix readily with heated gas; when the gas gives up its heat to the air and it in turn becomes heated, then they will mix and burn without smoke or soot.



Blast Pipes for an Air Furnace.

Among the many foundrymen, who, under the direction of their metallurgical chemists, have been reducing their pressures from time to time, it is a significant fact that a company in Chicago, operating probably the largest number of cupolas as well as the largest in size of any known to me, is one of the firmest believers in low blast pressures. In one of their many plants they are using two cupolas of

84 inches inside diameter, and a centrifugal fan blower to give 24,000 cubic feet of air per minute at 12 ounces pressure, in the wind box. Another of the largest firms in this country is using six to eight ounces in two 72-inch cupolas, and with positive blowers.

The position and shape of the tuyeres sometimes play a part in the proper distribution of the blast, and their height should be determined with due regard to the character of the work done and the charging of the cupola should be changed accordingly. For heavy castings the tuyeres should be higher than for light castings, and for stove castings a very low position of tuyeres is advisable, as the melting is practically continuous.

While I am an advocate of low pressure in cupolas for the reasons above stated, I am not an advocate of scanty volume or supply of air. Many foundrymen are using blowers far below the required capacity in volume; therefore they are compelled to speed up their blowers in order to get the necessary volume, thereby getting, incidentally, higher pressures than are essential to do the work, with poor results in their products, together with rapid destruction of cupola lining. This is undoubtedly one of the most important reasons for existence of high pressures in many foundries. High pressures give a greater melting capacity for a given size cupola, but better results at a less cost for power can certainly be obtained by using larger cupolas with lower pressures and larger volumes of air supplied through enlarged tuyere area. Under some conditions the desire for a high rate of melting outweighs other considerations and high pressures of blast must be used. But a sure sign of engineering is a willingness to invest in large and even expensive equipment if thereby the earnings on the investment can be increased.

Even with limited cupola capacity, the loss in melting capacity at the cupola with low pressures is often more than made up in the machine shop, by decreased cost in working up the product, as low pressures produce a soft casting easy to machine by reason of less loss of silicon and manganese by oxidation. Higher strength for the same reason is obtained under low pressures, as has been proven by government tests.

Combustion is never complete in a cupola. It requires a certain amount of oxygen to support combustion, and volume is fundamentally far more essential than pressure.

The action of the blast in the cupola is to oxidize a small portion of the carbon in the iron, and of the silicon and manganese also. Per contra, the iron absorbs some carbon from the fuel, sometimes sufficient to more than offset the loss by oxidation: not so with silicon. This is oxidized in proportion to the pressure or the intensity of the flame. A sufficiency of silicon produces soft castings by preventing the formation of combined carbon. Any increase of combined carbon increases the hardness of the castings. The oxidation of silicon and manganese is all the way from five per cent in the small cupolas to 20 per cent in the largest ones and pressure has no doubt considerable influence in affecting its quantity.

Reports received from some of our best foundrymen show what excellent results may be obtained by using low pressures of blast. These reports cover experiences with both fan and positive blowers in connection with various classes of foundry work, from castings for heavy fly wheels, engine and pump cylinders, stove work and castings, down to one-half ounce in weight. A large number of those using positive blowers are working under the lower pressures. In order to change from a high to a low pressure, of course the question of volumes must be considered and the foundryman must arrange his iron mixtures and fuel accordingly. Sometimes he must also change his manner of charging. But it will pay him to do this and melt at low pressures, unless, for instance, he is making sash weights from sheet metal scrap and old tin cans; or in case the cupola output per hour is the greatest consideration, or the castings

XUM

require no machining, or their appearance is of no consideration.

With the high pressures, extra loss by oxidation of silicon and manganese is only compensated for by purchasing the grades containing higher amounts of silicon, i. e., paying more for the iron by reason of rapid melting.

The iron as it comes from the spout of the cupola is far above its melting point. No definite rule can be given for the temperature at which it should be poured to meet the different requirements of different kinds of work. However, it is recognized that in pouring for thin castings, particularly those having small cores and thin projections, hot metal run slowly into the molds is the best practice. Heavy castings having few or no cores can be poured much more rapidly and the iron need not be so hot.

It is good practice, when making a line of goods where duplication is possible, and where the daily requirements are known, to arrange for hot iron and rapid pouring. This can be done when heats are long and practically continuous, where temperatures and fluidity can be run high. When I see the modern car wheel foundryman pouring hundreds of 700 pound car wheels per day in chills, I often ask myself, "Do the stove foundrymen really know what hot iron is?" They require at least two per cent silicon in their castings, but as you lower your rate of silicon so you can raise the temperature of pouring your metal.

Having discussed high and low blast pressures in the cupola, let me explain further by reference to tables III and IV.

For high blast pressures in cupolas we have the following capacities shown in table III:

TABLE III.

CUPOLA CAPACITIES WITH HIGH BLAST PRESSURES.

Dia. inside lining in inches.	Capacity per hour tons melted.	Pressure in ounces.
18	¼- ½	8
23	½ - 1	10
27	1 - 2	10
32	3 - 5	12
37	5 - 6	12
42	6 - 7	12
45	7 - 9	14
48	9 - 10	14
54	10 - 12	14
60	12 - 14	16
66	14 - 18	16
72	18 - 21	16
78	21 - 24	16
84	24 - 27	17

For low blast pressures we have the following capacities shown in table IV:

TABLE IV.

CUPOLA CAPACITIES WITH LOW BLAST PRESSURES.

Cupola inside lining in inches.	Capacity for hour—tons.	Pressure in ounces.
18	¼ - ½	5 - 7
23	½ - ¾	5 - 7
30	2 - 3-½	6 - 8
35	3 - 4	7 - 8
37	4 - 5	7 - 10
42	5 - 6	7 - 10
45	6 - 7	8 - 10
48	7 - 8	8 - 10
54	8 - 9-½	9 - 10
60	10 - 12	10 - 12
66	12 - 15	10 - 12
72	16 - 18	10 - 12
78	19 - 22	12 - 14
84	21 - 24	12 - 14

I consider the pressures in table III to be the maximum allowable or permissible for the best work, and they insure the greatest melting capacity in a given sized cupola. Very few foundrymen, however, care to utilize such high pressures as shown in table III for several reasons:

First:—Because they find they can get their required capacities at the lower blast pressures by using larger cupolas.

Second:—Because the cupola lining will last longer under lower pressures.

Third:—Because oxidation of the silicon and manganese is greater under high pressures.

Fourth:—Because the resultant castings are easier to machine when made under the lower pressure.

Fifth:—Because there is less slagging under the lower pressure, owing to the fact that you do not force the cupola.

Sixth:—Because greater strength in castings is obtained in melting at the lower pressures, all other things being equal.

Seventh:—Because the horsepower required per ton melted is less at low pressures than at high pressures.

Recapitulation.

Eighteen to twenty ounces might be designated as extremely high pressures in cupolas from 54 to 74 inches inside diameter of lining, and these pressures were formerly used with coal as fuel and with small tuyere area.

Low pressure, good sand, dry molds properly rammed and vented with good facing mixtures, together with reasonably hot metal having good fluidity, will make the smoothest castings. Having a lower per cent of combined carbon makes the castings softer and easier to machine, obtained more readily under pressures indicated in table IV.

Referring to fifth reason: The liability to slag is often caused by the too rapid passing of the blast through too small tuyere openings—too high velocity, too great a pressure freezing the metal near the tuyeres and producing slag. Too small a volume of air at these high pressures will not only make much slag but cause the iron to "hang" or "bridge" in cupola. The pressures specified in table IV will not produce as much slag per ton metal, all other things being equal, that is, quality of iron, flux, etc., as the extremely high pressures indicated in table III.

Referring to the sixth reason: The present practice among foundrymen is to buy coke and pig iron by analysis, rather than by fracture, as was commonly done years ago. They now insist upon getting their iron and coke low in sulphur. However coal, (hardly ever used now), having a high percentage of sulphur, particularly when melted in connection with pig iron high in sulphur, and a large percentage of very old, long exposed, inferior scrap, together with a slow rate in melting capacity,—slower than indicated in table IV,—would produce conditions most favorable to the absorption of sulphur in the casting; but with coke and iron as now purchased, the increased absorption of sulphur would be hardly appreciable, due to the difference in melting capacities, as indicated in tables III and IV.

The sulphur bugaboo, together with the clogging up of tuyeres, has ceased to be a terror to the foundryman who knows his business.

Enlargement of Tuyeres.

While I have never seen a cupola with too much tuyere area, I have stated definitely a limit. The tuyere is necessarily cut down considerably during the heat, and unless you have surplus tuyere area to start with, you will find you are short in area during the latter part of the heat. Our modern cupolas have greater tuyere area than cupolas formerly made, but even this is frequently enlarged to meet the demands of increased melting capacities at lower blast pressures; particularly when only the lower tuyeres are utilized.

The Blast Gate.

I have found quite a number of foundry foremen who do not use the blast gate. However for the very reason that foundrymen do not generally appreciate its importance, I find it desirable to speak of it. Unless a man does use a blast gate while operating a centrifugal fan with full volume capacity for cupola, he will not be able to get exactly the same quality of iron at all periods of the heat. Even users of positive blowers are now installing regulating rheostats to control pressure and volume of air blast during the heat, where previously this matter was not considered essential.

Absorption of Sulphur by Slag.

Low blast or pressure with sufficient volume will give hot iron and good fluidity. Many will say they get good hot iron with good fluidity at pressures lower than those in table IV. On the other hand, a cast steel company operating a positive blower at 17 ounces with 72-inch inside diameter cupola, has been getting dull iron, while their two neighbors, both operating cupolas of the same size, with practically the same size and character of blowers, are doing good work at very much lower pressures. A company in South Bend, Ind., is making beautiful and intricate castings by cheap labor and using pressures at 4 to six ounces in wind box, having reduced from time to time (after a long ex-

XUM

perience), from the higher pressures. They are not troubled with any sulphur. Other foundrymen have been reducing their pressures under the advice of their foundry chemists.

However, with pig irons and coke high in sulphur, the rate of melting has considerable to do with the amount of sulphur that will be absorbed in the castings. Fast melting permits the iron to absorb but little sulphur in comparison with slow melting, under abnormally low pressures. This possibly is one of the greatest arguments for fast melting.

Horsepower Per Ton Melted.

If we assume the price of a horsepower is $45 per year, the 30-ton heat will cost only from $1.50 to $2. If we assume the iron to be 2¼c per pound of casting, the cost of this power is 1-1000th of one per cent of the total cost of the iron or 2¼ thousandths of a cent per pound. Of course, if greater power is used a larger motor will have to be purchased, and the added expense of installation is more than the added expense of operation. The amount of power saved by more economical melting is small for one cupola, but in the case of a certain large corporation, operating a considerable number of large cupolas for heats of six to eight hours' duration, the difference in cost of power between the high and low pressures amounts to $25,000 per year, in favor of lower pressure.

If larger cupolas with lower blast pressures are used the same capacity per hour may be obtained as with smaller cupolas, and considerable horsepower be saved in consequence thereof. I do not mean to assume that the amount of air may be indefinitely increased by enlarging the tuyeres and not increasing the pressure. This may be done to a certain extent, but we soon reach a point where the equivalent area through the charge in the cupola is less than the tuyeres. If we take for instance two 84-inch cupolas to which are to be supplied 24,000 cubic feet of air per minute at a 10-ounce pressure, we note from our table of the velocities that 216 square inches area is required for the passage of 24,000 cubic feet of air per minute. The combined tuyere area of two 84-inch cupolas is 1,264 square inches, or about six times the area required to pass the stated amount of air at a velocity due to a 10-ounce pressure. In other words, it is the resistance of the charge which regulates the amount of air which can be forced through the cupola at given pressure by any type of blower and not altogether the area of the tuyeres, when these tuyeres are of a size which will make their total area larger than that which is required to pass the requisite amount of air. Just as increase of the tuyere area in a blast furnace would permit of a low pressure blast being used, so certain kinds of charges in cupolas require a higher blast pressure to force the air through them, regardless of any increase in tuyere area. By this I do not mean to belittle the importance of the size, arrangement and position of the tuyeres in the cupola. This is, as I have said, of great importance, but I think does not largely affect the volume when high pressure is used, particularly when obtained by means of the displacement blower.

The pressure limits the volume carried by any given pipe. In other words, a 12-inch pipe will carry a fixed volume of air at eight ounces pressure, but a larger volume at same pressure requires a larger pipe. It is therefore apparent that increased tuyere area and properly proportioned supply pipe and ample area in wind box is desirable for low

TABLE V.

Volume of air required per ton of iron melted.

6	lbs.	iron	to	1	lb.	coke	33,000	cu.	ft.	of	air	per	hr.	per	ton	iron	per	hr.
7	"	"	"	"	"	"	31,000	"	"	"	"	"	"	"	"	"	"	"
8	"	"	"	"	"	"	29,000	"	"	"	"	"	"	"	"	"	"	"
9	"	"	"	"	"	"	27,000	"	"	"	"	"	"	"	"	"	"	"
10	"	"	"	"	"	"	25,000	"	"	"	"	"	"	"	"	"	"	"
									"	"	"	"	"	"	"	"	"	"

The average is about 30,000.

pressure, when using the centrifugal fan blower. Inversely, when tuyeres are small, higher pressures are required to obtain the volume necessary, and then a blower of the displacement principle is required.

I find that the amount of air required to melt a ton of metal per hour depends principally upon the size of cupola, the ratio of coke to metal used in melting, the character of the coke, and the manner of charging. In a cupola, air is blown over the melted metal, not through it; the oxidation of carbon is slight and incidental, not fundamental and complete, as in a converter when air is blown through the metal. The volumes in Table V are approximately correct for air required per ton melted per hour:

Conclusions.

Less pressure required for coke than for coal.

More volume required for coke than for coal.

Larger tuyere area required for coke than for coal.

Coke more rapidly chilled by high velocity or pressure.

Tuyeres and lining will not burn out so quickly under the low blast pressures.

Too much air will reduce the temperature of the gases and retard combustion, particularly when introduced in top row of tuyeres.

The blast should be started at low pressure, and increased up to the maximum pressure required during the heat. The pressure should be lowered again at the end of the heat, for the reason that having less metal in cupola and more space around it, oxidation of silicon in the iron and the consequent hardening of the castings is prevented. Choked tuyeres are prevented by having large tuyere area with plenty of volume at low pressure, good iron and good fluxing.

Blast pressure is advisable, provided the cupola is large enough to give the required melting capacity, provided the blast pressure is not reduced enough to make melting unreasonably slow.

This paper would not be complete without an expression of my sincere thanks to the gentlemen who have so willingly responded to my questions concerning cupola performance.

DISCUSSION ON PAPER BY R. MOLDENKE—COKE TESTS OF U. S. GOVERNMENT.

In the discussion on my paper considerable interest was manifested on the point relating to the actual burning up of the iron in some of the heats run during the government coke tests. At the time I stated that the very first heat made burned up half of the iron charged, this oxidizing and going into the slag. Some doubt was also expressed as to the ability on the part of the iron to do this. Mr. Shed, afterwards, in reading his paper on "Fluxes in the Cupola," confirmed my experience.

While in St. Louis a few weeks ago, to start off the second series of government coke tests, I had the wind box of the cupola that made this bad heat cleaned out, and found in it, close to the slag spout, some of the very slag which foamed through the tuyeres, and caused us to drop bottom only to find no more iron there to melt. This slag was black and heavy, and on being analyzed in the government laboratory at the fuel testing plant, gave the following for iron and silica.

Analysis No. 3402.

Silica ..... 30.33 per cent.
Iron ..... 43.50 per cent.

which would seem to show that the iron was going "back to nature" again.

Foundrymen have often noticed that with improper charging and running conditions, generally accidental, that their iron would disappear, and the slag formed in melting foam up even out of the charging door. This is simply a Bessemerizing the cupola, and shows how liable this melting process is to oxidation effects.

I am glad to be able to give the above analysis, as I know it will interest foundryman and metallurgist alike.

RICHARD MOLDENKE.

XUM

EVILS AND RESTRICTIONS OF CARELESSNESS

BY THOS. D. WEST, SHARPSVILLE, PA.

This subject should interest Foundrymen and Manufacturers not only, but also the general public as well. In a message to Congress, President Roosevelt, in referring to injuries and deaths resulting from the practice of the mechanic arts, holds that the entire "risk of a trade" should fall upon the employer, whereas it is a fact that the greatest loss sustained by proprietors of industrial establishments is generally due to simple and deliberate carelessness on the part of their employees.

Much has been written on the need of experience and brains in making good castings, but very little on the restriction of carelessness, the greatest factor of loss to the foundryman in the way of bad castings, the loss of property, and the loss of life.

Considering the subject from its broadest standpoint, we are compelled to go without the four walls of the foundry. One has only to make it a point to preserve the newspaper clippings of accidents resulting from carelessness, and the resulting damage to property and life for a short time to learn what this means. We are so accustomed to reading of accidents in which the breadwinner of a family is suddenly cut off or horribly mangled, that we forget it in a short while, only to read of another case the day following. A compilation of such clippings will quickly show the seriousness of the matter and the need there is for restriction of this evil.

A few years ago the New York Bureau of Labor compiled statistics of accidents, showing there were 44 injured or killed annually to every 1000 workers engaged by factory employers. This would indicate that for the factory industries of this whole country there are 232,000 employees killed or injured annually. John Mitchell states that there are two miners killed and five injured for every working day in the year. Aside from the above we have the fatal injuries from horses, autos, street and railway cars. It has been stated upon good authority that the railroads kill and maim more than our wars. Of course it is true that all accidents are not due to carelessness, nevertheless it is safe to say that three-quarters of them are caused by the lack of thought, intelligence, or downright carelessness, and that there are a great many more accidents proportionately in brisk than in dull times, owing to the extra independence of employees to the restraint of overseers.

When an accident occurs in a foundry or other industry that maims or kills, the first thought of the public is as a rule to hold the employer responsible, and he is often looked upon as one who cares little or nothing for life or limb. The accident that took life might be such as to so destroy the shop, fixtures and tools and the cost to repair the damage might financially embarrass a firm or to eventually cause its failure.

Few outsiders or even the great majority of employees have any conception of how most employers dread accidents and strive to prevent them. The fact of the case is, that few if any accidents can occur without a stoppage of all hands to see what is the trouble, and if some one is killed outright, it unnerves many so that they either stand around with their pay going on, or go home and stop their work and often that of others.

Many outsiders do not have any other conception of the conditions that exist than that a corpse can be carted away like a piece of wood, and that this is the end of all expense and concern.

In reality the firm is held responsible in most all cases to pay doctors, hospital, funeral expenses, etc. Then, again, when proprietors have been charitable and considerate to the utmost in attendance on the deceased, who, in nine cases out of ten was killed by his own or another's carelessness, they hear the cry "Sue the firm," and shortly after are called upon by some petty lawyer with a claim of heavy damages. It is fitting here to question that if there exists a more contemptible, unprincipled being to take the form of man than the "shyster lawyer" who makes a practice of getting a living from unjust claims. He is a leech that would suck the last drop of blood of the

unfortunate maimed being that he professes a great interest in if this can turn him a penny.

It must be recognized that aside from accidents caused by willful carelessness, smart-Aleckism, etc., that some injuries are caused through faulty appliances and methods of working in our industries, and these may be classed into four great divisions—railroading, mining, manufacturing and building accidents.

State provisions are constantly being drawn for safeguarding against such accidents, and there are few employers who do not take an interest in this and live up to the state demands.

As one example of the value of state restrictions, it is said that the law compelling higher tops to railroad bridges has alone saved many hundred lives of brakemen annually, as the low bridges that did exist were continually knocking them off the box cars. Statistics obtained through the courtesy of Mr. Edward A. Moseley, secretary of the Interstate Commerce Commission, show that for the twelve years, 1893 to 1904, ending June 30th, there were 750 killed and 6100 injured on account of overhead obstructions.

Aside from the state regulation for the protection of life and limb, we have the guardian care of the overseer himself, a point on which much might be written. There are many occupations wherein a manager or foreman can be kept about as busy safeguarding life and limb as with the demands of actual shop or other work. In regard to foundries there are many that could maim or kill a man almost every day were not the watchful eye of the overseer constantly on the alert to control the actions of his smart-Alecks, dont-cares, careless and "dough-head" employees. Of this latter class it is woeful to see the things they will do. One has to often look at them in wonderment and question if they have any brains at all. The adage "He has grown to the size of a man, but has the brains of a goose," is not far from being correct.

When men of such low intelligence get hurt or killed, it cannot be said they are always careless; they are often so dull that they do not seem to know enough to step to one side if they saw a timber falling toward them. For this class it is hard to prescribe any remedy other than some guardian constantly watching their actions. There is certainly much involved in the watchfulness of an overseer to safeguard his workers. It is a factor that does not obtain the consideration and attention it should. It is perfectly practical for a watchful overseer to greatly decrease accidents causing loss of life and limb over what could occur in the case of an overseer who pays no attention to such matters, or works on the principle: "Let every one look out for himself." There is one thing certain, if many overseers had to stand the expense that the proprietors must in providing money and caring for the results of accidents, they would see through different lenses and look out closely for their under-workers as well as for themselves. There is no question but what a great number of overseers are deficient in this line, and that we should commence to give consideration to weighing an overseer's ability to safeguard those under his charge as much as to his executive strength in turning out quantity and quality of his firm's product. We must not ignore the fact that there are accidents due to the carelessness of overseers as well as operatives. Carelessness can be ascribed as in the following illustrations:

First. To the lack of proper restraint. As a rule, the man that has one or more jobs awaiting his acceptance is not the careful worker as the one who would not know where to get a job were he out of employment. He is beyond proper control.

Second. To the lack of responsibility. The man with no one to support but himself does not feel it necessary to be as careful as the father of a family.

Third. To a flippant disposition. The one who will not take work seriously is not the careful, safe being to have one's life or property in his keeping as the one who does.

These three illustrations attributing carelessness to the present inability to rightly control employees' and others'

XUM

actions and weigh them down with the responsibility they should carry, as well as a lack of seriousness in their natures, are all qualifications that hazard property and every person's life most every day of their existence; yet for all this the employer is to be saddled with one, if not the greatest, defect of man in assuming the "risks of a trade," if the view of the most respected and influential official in all civilization on the penalty for accidents is to be enforced in law.

Wherever there is a lack of proper restraint on workers, we must expect more accidents than otherwise, which demonstrates the necessity of employers having an influencing control of their employees. We can never be the practical people we should be until this deficiency is very greatly overcome.

Is it not time there was an awakening to the needs of a more practical training of the young and control of employees' actions to prevent loss of life and property than exists at the present time?

Can there be any form of education and training that is really more necessary to our existence than learning to be careful?

The second remedy lies in the enactment of laws whereby any person could be arrested, fined and imprisoned if found guilty of any carelessness that had resulted in maiming, killing or destroying property. Our laws are entirely too slack in this respect. Today a smart-Aleck or careless person can do any amount of uncalled for damage to property, saying nothing about the injury to his fellow workers, etc., and all the employer can do is to discharge him, and ten to one be laughed at for any voice he may give to vent his feelings for the gross injustice he and others have to suffer.

The third remedy that should be applied lies in devising plans to train youths to master, above all else, the quality of carefulness. We have our fire-drills for the purpose of preparing children to act in moments of peril. It would be no stretching of ingenuity to devise studies, methods and drills to develop and test carefulness. Where is there a school book today that contains a lesson on this life saving requisite? The adult that is graduated from college is no more trained in this important qualification than the child ending its primer.

If we casting manufacturers are to have less losses through carelessness in our plants, we must as a body get to the root of the evil, and this lies in assisting to shape the course of our educational systems and home training, as well as in aiding to develop a sentiment of respect and support for carefulness among the masses.

XUM

INDEX

PAGE

Address of President West 100
Air Furnaces; Comparative design and working of 46
Air Furnaces and Cupolas; A Plea for Lower Blast Pressures for 142
Alloys; A talk on 15
Analysis of Iron; Report on standard Methods of 29
Antisell: F. L.: Electricity in the Foundry 87
Associated Foundry Foremen; Convention Report of 99
Barrows, W. A. Jr.: The Influence of different Ore Mixtures on the resulting Pig Iron, from the Standpoint of the Foundry 79
Beds; Report on standard Methods of making 30
Belden, A. W.: Address on U. S. Fuel testing Plant 116
Beneficial Effect of Adding High Grade Ferrosilicon to Cast Iron 5
Best, T. J.: Manufacture of Soil Pipe & Fittings 9
Binders; Core 34
Blast Pressure, low, for Cupola and Air Furnace 142
Brass Founders' Association; Committee on 115
Carnegie Technical School; Report on 108
Carbon, total; Standard Method of determining 29
Carr, W. M.: Developments in the Thermit Process for Foundry 24
Cast Iron; Beneficial effect of adding Ferrosilicon to 5
Cleveland Convention Entertainment Features 121
Cleveland Convention; List of those in attendance at 131
Cleveland Convention; Transactions of the 97, 100
Cleveland Patternmakers' Club; Pattern Shop Equipment 39
Coke Tests, U. S.; Discussion on 150
Coke; U. S. Fuel Testing Plant. Foundry tests of 19
Coleman, W. H.: Low Blast Pressure for Cupola and Air Furnace 142
Convention Exhibits 124
Convention Souvenirs 138
Core Binders 34
Cost Finding; Uniform Practice in Foundry 22
Costs; Correct Application of true Burden to Iron 13
Crane, electric, in Foundry 31
Croxton, H. A.: Modern Pipe Foundry 91
Cupola; Design and working of Air Furnaces and 46
Cupola; Fluxes in the 89
Cupola and Air Furnaces; A Plea for lower Blast Pressures in 142
Diller, H. E.: Report on standard Methods of analyzing Iron 29
Election of Officers 114
Electric Crane in the Foundry 31
Electricity in the Foundry 87
Entertainment Features at the Convention 121
Equipment of Pattern Shop 39
Evils and Restriction of Carelessness 151
Exhibits at the Cleveland Convention 124
Falconer, Kenneth: Uniform Practice in Foundry Cost Finding 22
Ferrosilicon added to Cast Iron; Beneficial Effects of 5

PAGE
Fittings and Soil Pipes; Manufacture of 9
Fluxes in the Foundry 89
Founders' Supply Association 114, 117
Founders' Supply Association Officers 120
Foundry Costs; Committee on 116
Foundry Cost Finding; Uniform Practise in 22
Foundry Pig Iron; Effect of Ore Mixtures on 79
Foundry Practise; Dark Secrets in 16
Foundry Tests of Coke; U. S. 19
Iron Costs; Correct Application of true Burden to 13
Iron; Report on standard Methods of Analysis of 29
Laboratory Examination of Molding Sand 63
Lane, H. M.: Vote of Thanks for 116
List of those in attendance at Convention 131
Loudon, A. M.: Core Binders 34
McFadden, W. H.: President of A. F. A. Biography of 140
McQuillan, W. S.: Why good Molders are scarce 26
Machine Molding; Recent Methods of 59
Manufacture of Soil Pipe and Fittings 9
Metallurgical Section of the A. F. A. Report of Secretary of 29
Modern Pipe Foundry 91
Moldenke, Dr. R.: Discussion on U. S. Coke Tests 150
Moldenke, Dr. R.: Secretary's Report 106
Moldenke, Dr. R.: U. S. Coke Tests for Foundry 19
Molding, Machines; Recent Methods in 59
Molding Problems 18
Molding Sand; Laboratory Examination of 63
Molders, good; Scarcity of 26
Molds; Multiple 83
Multiple Molds 83
Mumford, E. H.: Recent Methods of Machine Molding 59
Officers elected for 1906-1907 114
Ore Mixtures; Influence of on Foundry Pig Iron 79
Outerbridge, A. E. Jr.: Beneficial Effects of adding High Grade Ferrosilicon to Cast Iron 5
Philadelphia Foundrymen's Association; Invitation for next Convention 116
Pig Iron; Influence of Ore Mixtures on 79
Pig Iron; 20 years' Improvement in quality of 56
Pipe Foundry; Modern 91
Parry, W. H.: Dark Secrets in Foundry Practice 16
Pattern Shop Equipment 39
Presidential Address 100
Problems in Molding 18
Report of Secretary 106
Report on Carnegie Technical School 108
Restriction and Evils of Carelessness 151
Ries, Prof. Heinrich; Laboratory Examination of Molding Sand 63
Sanborn, E. R. and E. H. Williams: 20 Years' Improvement in Pig Iron 56
Sand, molding; Laboratory Examination of 63
Sayer, Harry: Electric Crane in the Foundry 31
Seaman, J. S.: Report on Carnegie Technical School 108
Secretary's Report 106
Shed, N. W.: Fluxes in the Cupola 89

XUM

PAGE
Soil Pipes and Fittings; Manufacture of 9
Souvenirs at the Cleveland Convention 138
Spence, David: Molding Problems 18
Standard Methods of Analysis of Iron, Report on 29
Standard Method of determining Sulphur 30
Standard Method of determining Total Carbon 29
Standard Methods of making Beds, Report on 30
Sulphur; Standard Method of determining 30
Taylor, E. M.: The correct Application of true Burden to Iron Costs 13
Thermit Process, development in Foundry Practice 24
Thomas, E. H.: Report on Standard Methods of making Beds 30
Total Carbon; Standard method of determining 29
Transactions of Cleveland Convention 97, 100
Twenty Years Improvement in quality of Pig Iron 56
Uniform Practice in Foundry Cost finding 22
U. S. Coke Tests; Discussion on 150
U. S. Foundry Tests of Coke 19
Vickers, C.: A Talk on Alloys 15
Webb, Jas. F.: Multiple Molds 83
West, R. H.: Comparative Design and working of Air Furnaces 46
West, Thos. D.: Election as Honorary Member 115
West, Thos. D.: Evils and Restrictions of Carelessness 151
West, Thos. D.: Presidential Address 100
Williams, E. H. and E. R. Sanborn: 20 Years' Improvement in quality of Pig Iron 55